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NITROGEN

THE MAGAZINE OF WORLD NITROGEN

contents

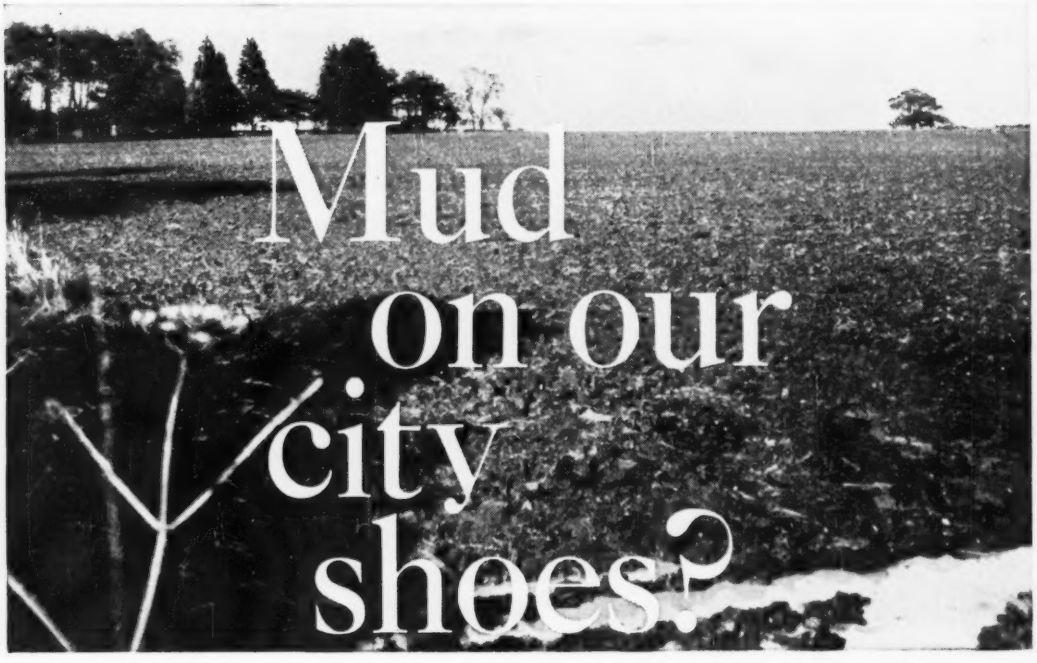
	page
Nitrogen Market in Scandinavia: Greater urea exports expected from Norway	1
New Hydrazine Process Developed by Bayer AG. Virtually no loss of final product	9
Mixed Pressure Nitric Acid Process for I.C.I.'s Ardeer Plant: Special features are efficient heat recovery and low catalyst loss	13
Novel Absorption Oxidation Column for Nitric Acid Production: Kuhlmann process gives 98% yields of NHO_3 of 70% strength	19
Dry Bleach Market Potentialities of Chlorinated Isocyanuric Acids	21
Fisons to be Second Largest Nitrogen Producers in the U.K.: £14m. ammonia and nitrogen products expansion	22
Supply—Trends—Prices: Nitrogen consumption at new peak	24
Freights: Tight supply situation for conventional tramp ships	30
Chilean Nitrate Production in 1960: Strikes affected production and exports	32
Expansion of Nitrogen Production in Roumania: Could lead to the country becoming an exporter	34
Chemico Methane Reforming Furnace Produces NH_3 Synthesis Gas at 250 p.s.i.g.: In operation at ONIA's Toulouse plant	35
Nitrilotriacetic Acid as Chelating Agent	36
TVA Increased Liquid Fertilizer Production in 1959-60	37
A 1,000 S.Tons-a-day Fertilizer Plant for California Chemical Company	40

Current Events

India	Texaco Plant for Travancore	41
	Nangal Plant in Operation	41
United States	Grace's 60,000 tons New NH_3 Capacity	42
	Dimethylhydrazine Plant Expansion	42
	New Air Separation Plants in U.S.	43
Mexico	Urea Plant for Salamanca	43
Peru	Fertisa in Production	43
Portugal	Ammonia and Urea Complex for Uniao Fabril do Azoto	44
	Nitric Acid for Explosives	44
France	Nitrogen Works for Donges	44
Syria	Site Chosen for N Fertilizer Plant	45
Indonesia	Urea Plant Contract	45
Taiwan	U.S./Chinese Urea Facility	45
Japan	Calcium Cyanamide Situation	46
Aruba	Nitrogen Products and Fertilizer Plant	46

Company Reports

Continued Rise in Output and Sales of Norsk Hydro	47
Statistical Appendix	49
Index to Advertisers	xiii



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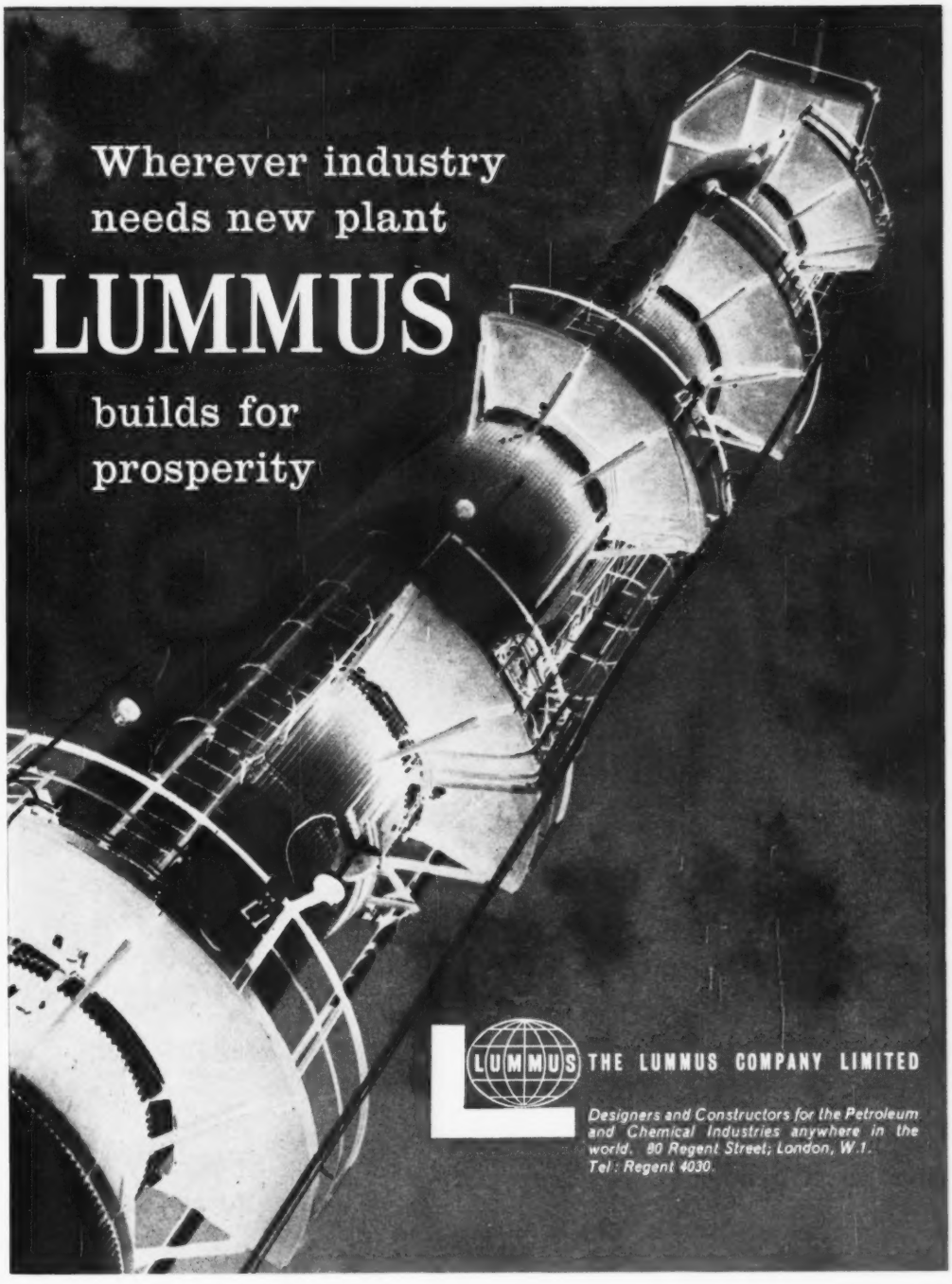
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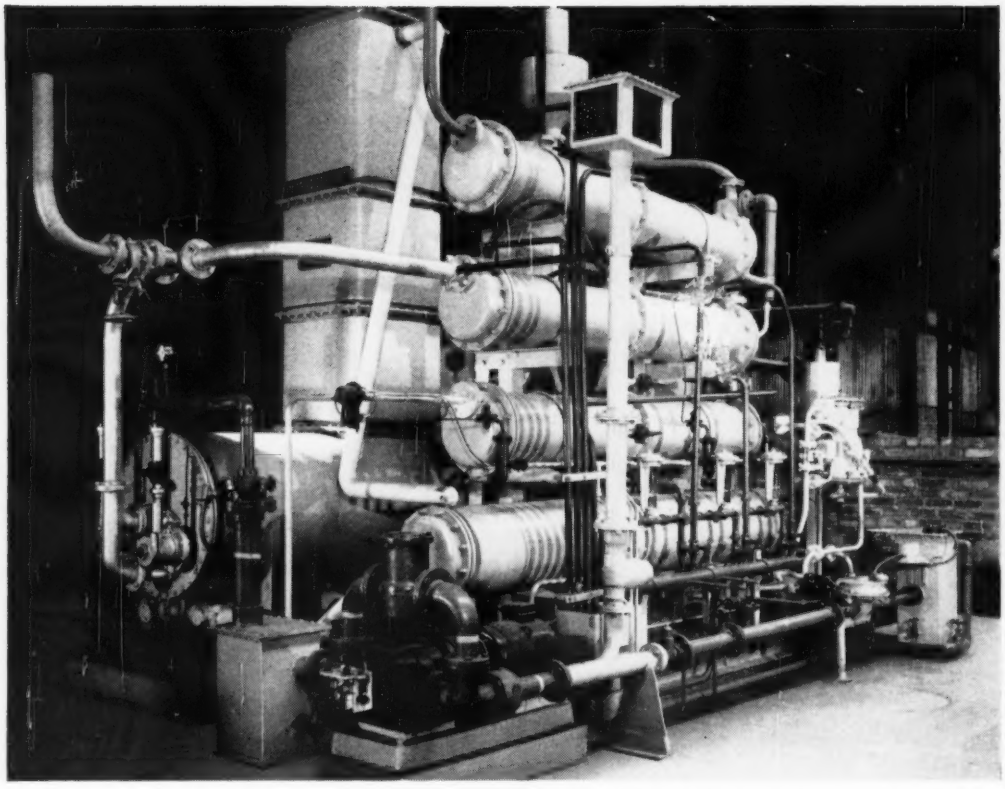

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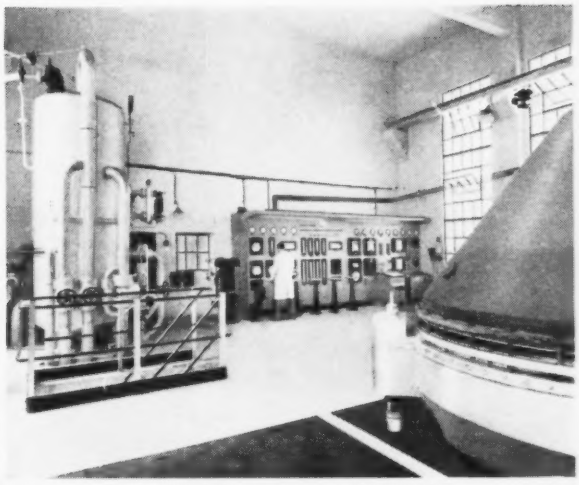
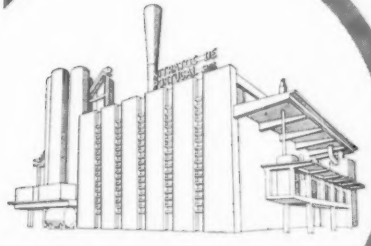
Interior of a nitric acid plant in South Africa, constructed and erected by Werkspoor.



HNO_3

Plants for nitric acid



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Nitrogen Market in Scandinavia

Greater urea exports expected from Norway

A view of the complete fertilizer plant of Norsk Hydro at Glomfjord

DOMINATING the Scandinavian nitrogenous fertilizer market to a very large extent is the output of the Norwegian firm, Norsk Hydro. Calcium nitrate produced by this company accounts for over 80% of the total Danish nitrogenous fertilizer market and for some 60% of the Swedish market; Finland also imports substantial quantities of this material. In the future, domestic production in Denmark will, however, to some degree decrease its dependence on Norway for nitrogenous fertilizer supplies, and Finland will be virtually independent of imports.

DENMARK

Consumption of fertilizer nitrogen in Denmark has increased from 75,795 tonnes N in 1954-5 to a level of 122,915 tonnes N in 1959-60; an increase of 47,120 tonnes N or 62%. Calcium nitrate is the most important nitrogenous fertilizer, and in 1959-60 consumption of this material amounted to 106,750 tonnes N or 86% of the total Danish nitrogenous fertilizer market. Relatively insignificant amounts of nitrogenous forms other than nitrate calcium are used in Denmark, the most important being, in the fertilizer year 1959-60: Chilean nitrate, 17,273 tonnes; ammonium sulphate, 9,933 tonnes; calcium ammonium nitrate, 8,381 tonnes; and ammonium sulphate nitrate, 4,364 tonnes. Consumption of fertilizer urea is small and amounted to some 200 tonnes in 1959-60, at which level it has remained since 1956-7.

Anhydrous Ammonia as Fertilizer

Of particular interest in recent years has been the increased use of anhydrous ammonia as a fertilizer in Denmark. Utilisation of this material as a fertilizer has been mainly confined to regions where the greatest crop response is shown to nitrogen and where fields are large and crops are grown at wide spacings, making possible the use of large injection rigs. In addition, anhydrous ammonia application is usually practised in areas where farmers are progressive and operate on a relatively large scale. As a result, its use has been largely confined to certain areas of the United States and to parts of Mexico. Consumption of anhydrous ammonia as a fertilizer in Denmark has, however, shown the following increases over the past five years:

	tonnes
1956	300
1957	350
1958	600
1959	2,500
1960	10,000

All Imported

Apart from a relatively small quantity of Nitrofoska imported from West Germany, no complete complex fertilizers have been used in Denmark.

There is as yet no domestic production of

Nitrogen Fertilizer Imports by Denmark

	1955	1956	1957	1958	1959	1960
Ammonium nitrate	7,539	24,595	10,626	12,226	7,082	17,057
Calcium nitrate	421,404	547,798	619,400	586,294	590,979	696,172
Ammonium sulphate	10,019	15,422	8,589	11,220	13,786	14,529
Sodium nitrate	18,429	26,459	26,460	8,910	16,433	20,039
Others	3,481	7,718	5,638	6,154	3,328	2,121

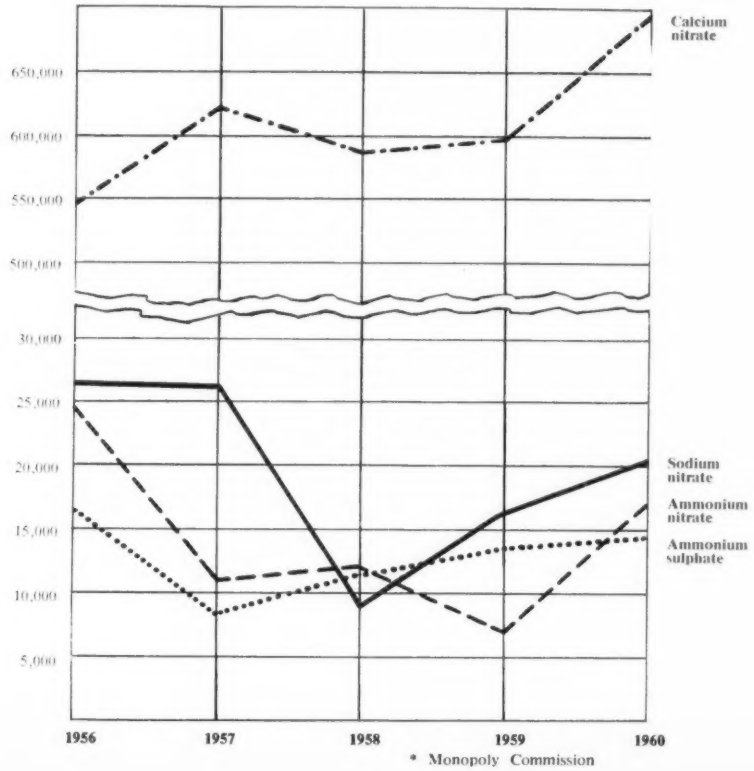
nitrogenous fertilizers in Denmark, and all are imported. (See table above.)

The major supplier is Norway, which supplies virtually all the calcium nitrate and anhydrous ammonia used in Danish agriculture. West Germany supplies a relatively small amount of calcium nitrate, most of the calcium ammonium nitrate and all the ammonium sulphate and ammonium sulphate nitrate.

Main Importers

There are four importers of calcium nitrate in Denmark, of which the two most important are Aktieselkabet Dansk Svovlsyre- og Superphosphat Fabrik, and Dansk Andels Gødningforretning, a co-operative. These two firms between them control 90% of the Danish calcium nitrate market and the remaining 10% is shared by Langelands Korn og Foderstof and Randers Korn og Foderstof. There are no import duties or import restrictions on nitrogenous fertilizers.

No subsidies on nitrogenous fertilizers are available in Denmark and the prices charged by the four distributing companies are uniform. All domestic prices are submitted to the Monopoltilsynet* and these are approved on



Denmark's nitrogen fertilizer imports

* Monopoly Commission

the basis of costs plus a reasonable profit and include early delivery rebates. In the 1960-61 fertilizer year, the ex-store price of calcium nitrate was fixed at Kr. 27.65 per 100 kilos (D.Kr. 19.35=£1) in October 1960, rising to Kr. 30.45 by June this year. Liquid anhydrous ammonia is imported by A/S Ammonia Limited, and its present cost to the farmer is Kr. 1.35 per kilo, applied on the farm.

Virtually all the nitric acid used in Denmark is imported by Dansk Svovlsyre-og Superphosphat Fabrik from Norway, and present usage is estimated at some 3,800 tonnes. Of this, one-third is used in the superphosphate industry, one-third is used in the dairy industry, and the remainder finds its way into a variety of other end-uses, including dyestuffs, pharmaceuticals, etc.

Fertilizer Production Plans

Production of nitrogenous fertilizers at Grenaa, Jutland, is planned by a company* formed by Dansk Svolvlsyre-og Superphosphat-Fabrik (40%), Dansk Andels Gødningsforretning (40%), and Norsk Hydro (20%). The new company's planned production will include 75,000 tonnes calcium ammonium (26%) and 10,000 tonnes anhydrous ammonia for sale as such. The new plant will supply part of the anhydrous ammonia used in Danish agriculture, but calcium nitrate imports will not be affected to any great extent.

FINLAND

Nitrogenous fertilizers are produced at Oulu by the Government-owned company, Typpi Oy. The plant came on stream in 1952 with a rated ammonia capacity of 60 tonnes per day, equivalent to some 16,000 tonnes N per annum. In 1957, capacity was doubled to 32,000 tonnes N, and in recent years the plant has operated slightly above rated capacity, as is shown in the following table :—

	Production tonnes N		
1952	1,009	1957	29,807
1953	13,071	1958	34,649
1954	17,265	1959	36,516
1955	16,637	1960	36,991
1956	16,669		

Fertilizer Output

The plant is designed to operate on a feedstock of either pulverised coal, using the Koppers Totzek gasification process, or heavy Bunker C fuel oil, but currently only the latter is used. Apart from ammonia, other units at the fertilizer complex at Oulu have the following maximum capacities :—

Calcium Ammonium Nitrate	30,000 tonnes N
Nitrogen Solutions	13,000 tonnes N
NPK Fertilizer (12.9.17)	7,200 tonnes N
Total	**50,000 tonnes N**

It will be noted that end-product capacity exceeds ammonia capacity by some 50%, and there is consequently a great degree of flexibility in production. Over the last three years, actual production and sales have been as shown in the table below.

Apart from Typpi Oy, there is only one other producer of nitrogenous fertilizers in Finland, Kymin Oy at Kuusankoski. This company produces calcium cyanamide, but production is small and has fluctuated between 350 and 650 tonnes N in recent years.

Consumption of N Fertilizers

Consumption of fertilizer nitrogen in Finland has increased from 27,978 tonnes N in 1952, to a level of some 53,000 tonnes N in 1960, the use of nitrogen solutions and compound fertilizers showing particularly marked

Finland's Nitrogen Production and Sales, 1958-1960

	Production tonnes			Sales		
	1958	1959	1960	1958	1959	1960
Calcium Ammonium Nitrate 25% N						
Compound Fertilizer	109,824	111,391	76,832	92,219	103,892	104,586
12.9.17 and 14.11.12	20,675	—	—	18,769	—	—
12.9.17 and 12. 6.24	—	23,995	—	—	27,365	—
12.9.17 and 12.15.18	—	—	46,623	—	—	46,166
Nitrogen Solutions (40% N)	6,229	7,643	25,961	5,815	7,644	25,805
Total Fertilizer N	32,561	33,796	35,357	27,674	32,461	42,705
Technical N	2,088	2,720	1,634	2,088	2,720	1,634
Total Production of N	**34,649**	**36,516**	**36,991**	**29,762**	**35,181**	**43,705**

* Nitrogen No. 8, 1960, p.42

increases in recent years. In 1957 only a few tons of the former were produced for experimental use on pasture and cereals, but nitrogen solutions have grown in popularity so much since that sales have quadrupled in the past three years.

Imports by Finland

Imports in 1959 amounted to 78,081 tonnes, of which the bulk was in the form of Norwegian calcium nitrates, 40,256 tonnes. In the same year, West Germany supplied 32,083 tonnes of ammonium sulphate nitrate and other imports, from a variety of sources, including ammonium nitrates, 3,911 tonnes; ammonium sulphate, 500 tonnes; urea, 911 tonnes; and sodium nitrate, 320 tonnes. All fertilizer imports are liberalised and are also free of duty.

Subsidies and Rebates

All fertilizers in Finland are subsidised and retail prices also include early delivery rebates. The amount of subsidy has varied greatly since 1947, the year of introduction. In 1948-49, the total State aid (including purchase certificates for smallholders) amounted to 1,343 million Fmks (Fmks. 888.9=£1) or 41.7% of the total cost of the fertilizers. In the period 1949 to 1951 the total aid decreased somewhat but increased in the following year and reached a record level of 62% in 1952-53, since when it has declined. In 1959-60, fertilizer subsidies amounted to only 6.8% of the cost of fertilizers.

Retail Prices of Nitrogenous Fertilizers, 1961*

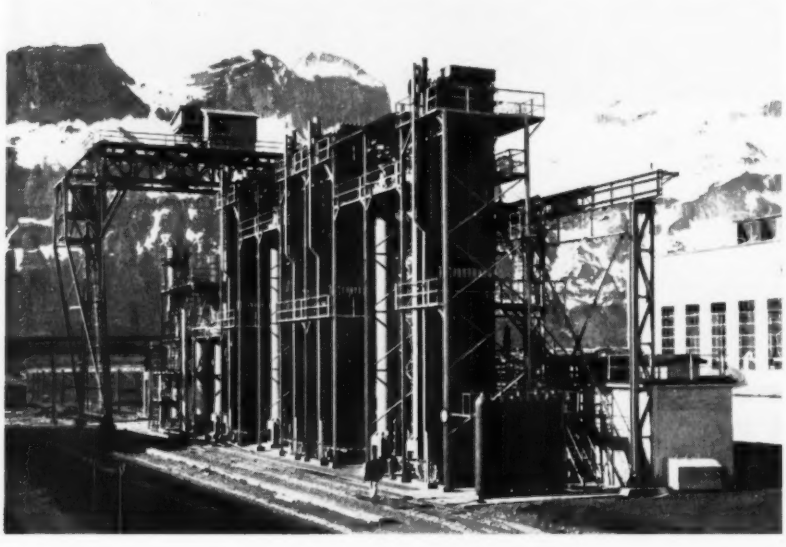
	January £ per mt.	February £ per mt.	March-June £ per mt.
Nitrate of Lime ...	17.6	18.2	18.5
"Oulu" Nitrate ...	24.2	25.2	25.4
Ammonium Sulphate	19.9	20.6	21.0

* Excluding subsidies

Expansion Plans

In the future, expansion presently being undertaken at Oulu will increase capacity there by some 50% to a level of 50,000 tonnes N by the end of next year. It is of interest that the capacity for end-products already installed at Oulu is sufficient to utilise the increased production of ammonia and the company will not require additional facilities for processing ammonia.

In 1960, a Government committee, appointed to investigate nitrogen production, recommended that a new 16,000 tonnes N per annum ammonia plant be built at the State-owned oil refinery, Neste Oy, at Naantali. Plans have, however, been shelved for the time being.



Norsk Hydro's synthetic ammonia plant at Glomfjord

Norwegian Nitrogen Production, 1955-1960

	1955-56	1956-57	1957-58	1958-59	1959-60
Calcium Nitrate tonnes N	135,500	168,000	163,600	168,300	177,700
Calcium Ammonium Nitrate tonnes N	19,900	12,300	13,200	8,300	9,900
Calcium Cyanamide tonnes N	500	300	2,500	3,500	5,000
Fertiliser Urea tonnes N	8,300	8,900	14,000	18,900	25,000
Complete Complex Fertilisers tonnes N	14,400	24,600	25,600	27,100	25,000
Total N Fertilisers	178,600	214,100	218,900	226,100	242,600
Technical Nitrogen (including technical urea)	12,700	14,400	11,700	17,000	23,800
Total N Production	**191,300**	**228,500**	**230,600**	**243,100**	**266,400**

NORWAY

Ammonia is produced in Norway by Norsk Hydro (in which the Government holds a 48% share) at Rjukan, Glomfjord and Notodden, the total capacity being equivalent to 270,000 tonnes N a year. The Notodden works, with an annual capacity of 10,000 tons N was erected in 1905 and is one of the oldest ammonia plants still in existence in the world. The plant at Rjukan was erected six years later and has been expanded subsequently so that capacity now amounts to 195,000 tonnes N, making it the fourth largest plant in Western Europe. Ammonia from all three plants is shipped to Norsk Hydro's works at Eidanger for use in the manufacture of nitrogenous fertilizers, although both at Rjukan and Glomfjord a proportion is retained for the production of calcium nitrate. At Eidanger, about 190,000 tonnes of ammonia are processed each year and end - products include calcium nitrate, ammonium nitrate, calcium ammonium nitrate, compound fertilizers, and urea. Because of the existence in Norway of abundant and very cheap hydroelectric power, all three ammonia plants derive their hydrogen for ammonia manufactured from electrolysis. As a result, in periods of severe drought ammonia production has been curtailed as occurred in the summer of 1959, when output of the Notodden plant was adversely affected by power shortages.

Norsk Hydro's Production

Actual production by Norsk Hydro has increased over the past five years from a level of 191,300 tonnes N in 1955-56 to 266,400 tonnes N in 1959-60, an increase of 73,100 tonnes N, or nearly 40%. Some 70% of Norway's nitrogen production is in the form of nitrate calcium, a product with physical characteristics which tend to confine its use to dry conditions such as are found in Egypt and Spain. Its widespread use in Denmark, and to a lesser extent, Sweden and Finland, is largely the result of tradition and the preference for a quick-acting form of nitrogen where growing seasons are short. Nearness to the point of manufacture also means that the less satisfactory nature of the material, as far as transport and storage are concerned, is of less importance than in other countries.

Formula for Complexes

Complex fertilizers are produced by Norsk Hydro at Glomfjord and Eidanger, using a process developed by Norsk Zinkkompanie, at Odda. Three different formulæ are manufactured, the total annual output of all three being in the region of 200,000 tonnes. The three materials analyse as follows :—

	Compound A	Compound B	Compound C
	%	%	%
N	12.5	11.5	15.0
P	5.5	5.0	6.7
K	15.0	14.5	12.0
Mg ...	1.2	1.2	—
S	1.6	7.5	—
B	0.03	0.03	0.03

All the Compound A and some of the Compound B is manufactured at Glomfjord, and the remainder of Compound B and all the Compound C is produced at Eidanger.

Calcium cyanamide is manufactured by Odda Smelteverk A/S at Odda.

Domestic Consumption

Domestic consumption of nitrogenous fertilizers is currently at a level of some 46,000 tonnes N and has remained virtually static over the past four years. Over the past six years there has been a big increase in the use of complex fertilizers which have risen from a level of 8,100 tonnes N in 1954-55 to some 26,000 tonnes N in 1959-60, but this has been partially counterbalanced by a decrease in calcium ammonium nitrate and calcium nitrate consumption, of some 8,000 tonnes N over the same period.

Prices

Retail prices for fertilizers were fixed by the Directorate of Prices in 1951, and have varied little since. Nitrogenous fertilizers are subsidised at both the farmer and the producer level. Prices in the current year are shown below.

Large Exports

Norwegian production of fertilizer nitrogen exceeds domestic consumption by nearly 200,000 tonnes N and consequently very considerable quantities are exported each year. Calcium nitrate at a level of 1,098,864 tonnes in 1959-60, is the most important exported nitrogenous material and accounted for 95% of all nitrogenous fertilizer exports. Of this quantity, approximately one million tonnes was exported to other Scandinavian countries and the remainder, about 100,000 tonnes, was exported mainly to the U.S.A. for use in the citrus industry, and to Spain. Urea production in Norway has grown from 42,000 tonnes in 1957-58 to a level of 73,000 tonnes in 1959-60, and since domestic consumption, entirely for industrial use, amounts to some 2,000 to 3,000 tonnes only, considerable quantities are available for export.

Norwegian Fertilizer Exports

tonnes

	1957-58	1958-59	1959-60
Ammonium Nitrates	1,589	2,817	2,967
Calcium Nitrate	989,373	971,384	1,098,864
Calcium Cyanamide	10,176	6.914	828
Mixed Fertilizers	—	—	7,723
Other Nitrogenous Fertilizers	—	27,492	41,805
Sodium Nitrate ...	1,369	735	—

Fertilizer Imports

All imports of nitrogenous fertilizers into Norway are exempt from import duty, and are not subject to any quantitative import restrictions. For reasons that are immediately obvious, however, nitrogenous fertilizer imports are very small, and are restricted to some 200 to 500 tonnes of ammonium sulphate annually.

Nitrogen Capacity Expansion Plans

In the future, expansions at present under way will increase fixed nitrogen capacity at Glomfjord from 65,000 tonnes N to 86,000 tonnes N. Additional expansion at Norsk Hydro's existing plant is, however, severely

Norwegian Retail Prices of Nitrogen Fertilizers

	May/June Price 1960-61	Seasonal Price in November	Net Price In November
		* Kr. per 100 Kilos	
Calcium Nitrate			
bulk f.o.b. works	20.10	18.50	18.10
bulk f.o.b. Oslo	23.50	21.90	21.43
bagged f.o.b. works	22.80	21.20	20.74
bagged f.o.b. Oslo	26.20	24.60	24.08
Calcium Ammonium Nitrate			
bulk f.o.b. works	26.00	24.40	23.88
bulk f.o.b. Oslo	29.40	27.80	27.21
bagged f.o.b. works	28.70	27.10	26.53
bagged f.o.b. Oslo	32.10	30.50	29.86
Compound Fertilizer A			
f.o.b. works	40.30	37.70	36.89
Compound Fertilizer B			
f.o.b. works	42.60	40.00	39.15
f.o.b. Oslo	46.00	43.400	42.48
Compound Fertilizer C			
f.o.b. works	39.40	36.80	36.01
f.o.b. Oslo	42.80	40.20	39.34

* N. Kr. 20.03=£1.

limited by the availability of electric power. At present most of the electricity used by Norsk Hydro is produced by the company itself, although approximately one-half of the requirements of its works at Rjukan is purchased from a State-owned power station. By a law passed after the First World War, the Government stipulates that privately-built power stations must be sold to the State after 65 years, and in view of the deterrent effect of this law, Norsk Hydro is unlikely to undertake construction of the large power station which would be necessary for a major expansion in ammonia capacity at one of their existing plants.

In view of the foregoing, it is likely that any new capacity will utilise a route for hydrogen manufacture other than that of electrolysis. In this connection, reports that Norsk Hydro may manufacture ammonia at Mo i Rana, using waste gases from a projected coke-oven works, are of especial interest. Whatever the outcome of this plan, however, Norway is expected to play only a subsidiary role in the nitrogenous fertilizer export market outside Scandinavia.

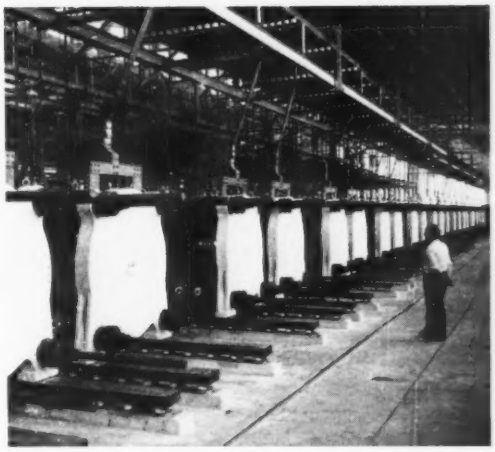
SWEDEN

There are two primary nitrogenous fertilizer producers in Sweden: Svenska Skifferolje Aktiebolaget at Kvantorp, and Stockholms Superfosfat Fabriks A/B at Ljungaverk and Stockviksverken. The former company produces ammonia using hydrogen derived from shale distillation and actual production has increased by 21,909 tonnes over the last five years, as shown by the following table:—

Ammonia Production
tonnes

1956	734
1957	5,684
1958	14,456
1959	16,085
1960	22,643

All this ammonia is sold to Svenska Saltpeterverken for eventual nitrogenous fertilizer manufacture. A small amount of by-product ammonia is produced during shale distillation, and this is neutralised with bought-in sulphuric acid. By-product ammonium sulphate produced in this way by Svenska Skifferolje has remained at an annual level of some 2,000 tonnes over the last five years.



Hydrogen electrolysers of the Norsk Hydro plant

Ammonia is also produced by Stockholms Superfosfat Fabriks A/B at Ljungaverk in a plant of 20,000 tonnes N capacity. Most of the ammonia is processed into nitric acid, for the manufacture of calcium ammonium nitrate fertilizer (" Ljungasalpeter " 23% N), but there is also a small output of ammonium sulphate. A urea plant of 600 tonnes capacity was installed in 1938 but has not been in operation for some years. Hydrogen for ammonia manufacture is obtained electrolytically.

Calcium Cyanamide Plant

At Stockviksverken, Stockholms Superfosfat Fabriks A/B have a calcium cyanamide plant of some 20,000 tonnes N capacity. Two grades are produced, an oiled calcium cyanamide with a nitrogen content of 20-21% and a granulated calcium cyanamide analysing 18%N. The company also manufactures other products based on cyanamide at Stockviksverken, such as dicyandiamide, melamine and products thereof, for industrial use.

Svenska Saltpeterverken manufactures both straight nitrogenous and complex fertilizers at Koping, using ammonia purchased from Svenska Skifferolje. Much of this ammonia is used for calcium ammonium nitrate (25% N) manufacture (capacity 130,000 tonnes per annum) but there is substantial capacity for complex fertilizers (70,000 tonnes per annum) based on nitrophosphate. Three grades of complex fertilizers are manufactured, 13-10-13,

13-10-9 and 10-10-15, the latter containing potash in the sulphate form for use on potatoes and other chloride sensitive crops. Actual demand for complex fertilizers in Sweden is relatively low and the plant has operated below capacity since its installation.

By-product ammonium sulphate is produced by the gasworks at Stockholm of Stockholms Gas Och Vattenverk and by Oxelosunds Jarnverk at Oxelosund. The output of both companies is small and amounts to some 5,500 tonnes annually.

Increased N Fertilizer Production

Output of nitrogenous fertilizers has increased from a level of 27,489 tonnes N in the fertilizer year 1953-4 to an estimated 34,000 tonnes N in 1959-60, a small increase of 24%. Over the same period, output of calcium ammonium nitrate has doubled to its present level of 26,000 tonnes N, but this has been largely counterbalanced by decreased ammonium sulphate and cyanamide output. Complex fertilizer manufacture began in 1956-7 and is now equivalent to some 2,000 tonnes N.

Locally produced fertilizers supply less than one-half the domestic market, which is currently at a level of 89,000 tonnes N. Calcium nitrate is the most widely used material and accounts for some 55% of the Swedish nitrogenous fertilizer market, but has lost ground in recent years to higher analysis materials such as calcium ammonium nitrate and complex fertilizers. Consumption of both ammonium sulphate and cyanamide has declined in recent years.

Swedish Imports, 1959-60

Sodium Nitrate, natural	33,992
Sodium Nitrate, synthetic	538
Ammonium Nitrate, fertilizer grade	164
Ammonium Sulphate	12,431
Calcium Nitrate	347,911
Sodium Nitrate, synthetic	538

Imported Products

Calcium nitrate is the most important imported material and in 1959-60 347,911 tonnes was imported, nearly 90% of total imports. Norway is the main supplier, though significant quantities (about 10%) originate from the Netherlands.

Calcium nitrate, sodium nitrate, and calcium cyanamide are imported duty free, but ammonium nitrate, ammonium sulphate nitrate and urea bear an import duty of 12% ad valorem, and ammonium sulphate carries a duty of SW.Kr. 3 per 100 kilos.

Swedish Retail Prices of Nitrogen Fertilizers

Calcium Ammonium Nitrate 25% N		
f.o.r Koping, packed in 100 kg. paper bags		
1 October 1960—31 January 1961	Sw. Kr. 31.55	per 100 kg.
1 February 1961—31 May 1961	" " 32.90	" " "
1 June onwards	" " 34.70	" " "
Calcium Ammonium Nitrate 20.5% N		
f.o.r. Ljungaverk, packed 100 kg. paper bags		
1 October 1960—31 January 1961	Sw. Kr. 27.15	per 100 kg.
1 February 1961—21 May 1961	" " 28.25	" " "
1 June onwards	" " 29.75	" " "
Calcium Nitrate		
f.o.b. port of entry, packed 100 kg. paper bags		
1 October 1960—31 January 1961	Sw. Kr. 21.85	per 100 kg.
1 February 1961—31 May 1961	" " 22.95	" " "
1 June onwards	" " 24.05	" " "
Ammonium Sulphate		
f.o.r. Kvantorp, packed 100 kg. paper bags		
1 October 1960—31 January 1961	Sw. Kr. 25.25	per 100 kg.
1 February 1961—31 May 1961	" " 26.25	" " "
1 June onwards	" " 27.75	" " "
Calcium Cyanamide 20/21% N		
f.o.r. Stockvik, packed 100 kg. paper bags		
1 October 1960—31 January 1961	Sw. Kr. 31.30	per 100 kg.
1 February 1961—31 May 1961	" " 32.30	" " "
1 June onwards	" " 33.80	" " "
Calcium Cyanamide, Granulated, 18% N		
f.o.r. Stockvik, packed 100 kg. paper bags		
1 October 1961—31 January 1961	Sw. Kr. 28.70	per 100 kg.
1 February 1961—31 May 1961	" " 29.70	" " "
1 June onwards	" " 31.20	" " "

Sw. Kr. 14.51 = £1.

There are no subsidies on nitrogenous fertilizers in Sweden, but the manufacturers and importers offer early delivery rebates to their customers for the year 1960-61 as shown on Page 8.

OUTLOOK

With the exception of Finland, and to a lesser extent Denmark, nitrogen consumption in Scandinavia has shown little change over the last three years. As a result of increased production in the former country and new production in the latter, consumption in both is likely to increase. In Norway and Sweden, fertilizer consumption is unlikely to increase significantly in the immediate future, though in the latter country, fertilizer application per acre of agricultural land (23lb. N) is low in comparison with many other European countries.

With the exception of Finland, which will be virtually self-sufficient by the end of 1962, Scandinavia will continue to receive most of its nitrogen supplies from Norway in the future. Broadly speaking, Scandinavia can be regarded as a self-sufficient area, and one in which it is unlikely that there will be any large increase in productive capacity in the near future, after projects planned or under construction in Denmark, Finland and Norway have been completed. Surpluses of conventional nitrogenous fertilizers in Norway will be mainly sold within Scandinavia and are expected to play only a minor role in world fertilizer export trade outside Scandinavia. Norwegian urea capacity, however, at present at a level of 100,000 tonnes, is far in excess of Scandinavian requirements and it is likely that considerable quantities (approximately 80-90% of total output) will be exported outside Europe for fertilizer use.

New Hydrazine Process Developed by Bayer AG.

TWO operational steps are involved in a new process for hydrazine production developed by Farbenfabriken Bayer AG. of Leverkusen, West Germany: Hydrolytic distillatory cleavage of ketazine solutions and treatment in strong caustic solutions. The process allows hydrazine solutions containing sodium chloride as obtained in the Raschig synthesis to be worked up economically. It is claimed that virtually no losses of hydrazine occur.

Process Steps

A weak (1 to 2%) hydrazine solution is produced by the usual Raschig process from sodium hydroxide solution, chloride and aqueous or anhydrous ammonia in excess. Hydrazine is separated by distillation using a process developed by Bayer whereby acetone is added in the form of dimethyl ketazine solution.

Essential factor in the process is that aqueous ketazine solution is distilled below the boiling point of water, and that hydrazine is readily concentrated in the distillate.

Virtually no loss of final product

The aqueous ketazine solutions of 5 to 10% concentration of hydrazine are hydrolyzed by acid into acetone and hydrazine salt. Hydrazine hydrate can be obtained from the salt in the usual manner by means of sodium hydroxide. It is possible to avoid this step, Bayer believes, by splitting ketazine hydrolytically into acetone and hydrazine and separating the two components from each other by distillation. This step is only economic up to a ratio of acetone to hydrazine of about 0.4 in the distillation residue.

Further removal of acetone from the concentrate can be achieved by addition of strong alkali, acetone containing aqueous hydrazine solution is separated into two phases in which the upper contains all the acetone and hydrazine in the molar ratio of 1 : 1 i.e. as acetone hydrazone, while the lower layer contains the residual hydrazine in free form and the caustic soda solution.

A concentrated hydrazine solution is obtained from this solution by simple distillation.

Proposals Invited for Establishment of a Nitrogenous Fertilizer Complex in Rhodesia

LOCAL production of nitrogenous fertilizers in the Federation of Rhodesia and Nyasaland is regarded by the Federal Government as a matter of the utmost urgency, because of the revolutionary benefits which cheap fertilizer would bring to all branches of agriculture*.

Proposals Sought for Plant

For some time to come the local market for nitrogenous fertilizers will only be capable of supporting one producing unit—even when the demand for nitrogen for explosives is taken into account. To enable the Government to select the concern with whom to work for the establishment of such a plant, it has been decided to invite proposals from companies both inside and outside the Federation for the investment in and the early setting up of such a factory. Proposals must be submitted before 30 September 1961 and should contain sufficient data to enable the Government to be able to choose between different projects.

Explosives Included

In the national interest, the Federation is anxious to see fertilizers produced at the lowest possible prices and with maximum use made of local resources. Nitrogenous fertilizer production is the main concern at present but explosives are included in case the scale and cost of production require the two to be continued to obtain the lowest possible fertilizer price. There will be no objection to proposals which include the manufacture of nitrogenous fertilizers and of explosives by companies independent of one another.

Benefits for the Federation

Nearly three-quarters of the people of the Federation depend on agriculture for a living but nitrogenous fertilizer has, except in certain limited fields, been little used as with the high prices obtaining farmers are afraid heavy dressings may prove uneconomical in unfavourable seasons.

On the basis of nitrogen being available at a very low price per ton, and having regard to agricultural objectives, Federal and Territorial Departments of Agriculture have provided demand estimates (table below). Total demand for nitrogenous fertilizer and explosives in terms of N equivalent exceeded 30,000 tons in 1960 and has been increasing at an average rate of 11% a year. The average percentage increase in demand for N fertilizers has been about 15% a year between 1956 and 1960 and demand was 22,000 tons in terms of nitrogen equivalent in 1960. At this rate of increase total demand for N fertilizer, it is estimated, should exceed 30,000 tons N in 1963.

Raw Materials

The use of coal is discounted as it is already substantially more expensive than that used by South African nitrogen industry. A plant based on fuel oil would not be an economic proposition. This then leaves the electrolytic plant.

The Federation's Ministry of Power is therefore investigating whether the size and peculiar quantities of the proposed load for electrolytic processing would justify a tariff below the incremental rate for Kariba power at £7 per KW a year and 0.1d. per KWh.

In Roskill's report, the adoption of the Sherritt-Gordon ammonia leaching process for metal recovery was suggested for the copper belt area. This process requires a large tonnage of ammonia and results in production of considerable quantities of by-product ammonium

Estimates of N Demand

	'000 Tons 1964	1965	1966
Southern Rhodesia African Agriculture	5.2	6.2	7.2
Northern Rhodesia African Agriculture	4.5	5.0	6.5
Nyasaland African and European Agriculture	3.0*	3.5*	4.0*
Federal European Agriculture	25.0	26.0	27.5
	37.7	**40.7**	**45.2**

* Inserted by the Minister of Commerce and Industry (Not put forward as official estimates)

* Nitrogen 10, March 1961, P.17.

† Report of Possibilities of Establishing a Plant to produce nitrogenous Fertilizer in the Federation of Rhodesia and Nyasaland. O. W. Roskill, 1956.

Total Demand (at Market Prices) for Nitrogenous Fertilizers and Explosives in Terms of Nitrogen Equivalent

	'000 Short Tons					Average Annual Rate of Increase
	1956	1957	1958	1959	1960	
Southern Rhodesia	8.7	10.0	10.8	12.7	16.6	17%
Fertilizers						
Northern Rhodesia	2.5	3.3	2.9	3.1	3.7	10%
Nyasaland	1.4	1.5	1.9	2.0	2.2	14%
Federation	12.6	14.8	15.6	17.8	22.5	15%
Explosives (a)	7.0	7.0	6.5	8.0	8.0	—
Total in terms of Nitrogen ...	**19.6**	**21.8**	**22.3**	**25.8**	**30.5**	**11%**
Percentage increase	—	11%	2%	16%	18%	

(a) Very approximate figures

sulphate. Such a plant is being installed by Marinduque Iron Mines Agents Inc. in the Philippines*. Ammonia demand could be quite substantial if a similar plant were set up in the Federation.

The Anglo-African Corporation of South Africa Limited, which exploits low-grade copper sulphide ores in Northern Rhodesia, is understood to be interested in the Sherritt-Gordon process if cheap ammonia could be made available, or alternatively the company might be interested in producing ammonium sulphate from flue gases, if cheap ammonia was obtainable and an assured market for the fertilizer product provided.

The Federal Ministry has also noted that large quantities of ammonium sulphate—estimated to be at least 1 million tons—will be produced shortly in Europe and marketed as a by-product of caprolactam which is a basic material used in the manufacture of nylon*.

The Ministry has noted the recommendation of the I.P.E.C. consultants that a nitrogen industry and a heavy chemical industry could be established between Kafue Valley and Lusaka. This location not only has limestone required for making calcium nitrate but is a favourable location for an explosive plant and is centrally situated for supplying nitrogenous fertilizers to southern and northern farming areas.

The Ministry believes that the foregoing recommendation deserves consideration since although cost of railing fertilizers from Kafue to Salisbury and from Kitwe to Salisbury would be £2 4s. 0d. per short ton and £2 16s. 3d. per short ton respectively, the economics of an

Sales of Nitrogenous Fertilizer in Terms of Tons of Nitrogen*

	Total Sales: '000 Tons In Terms of Nitrogen Equivalent				
	1956	1957	1958	1959	1960
Southern Rhodesia:					
Calcium ammonium nitrate	0.6	0.6	1.2	3.0	4.5
Sulphate of ammonia	4.0	3.9	3.3	1.7	0.9
Urea	0.8	1.7	2.2	3.6	5.7
Compounds	3.3	3.8	4.1	4.4	5.5
Total Southern Rhodesia	**8.7**	**10.0**	**10.8**	**12.7**	**16.6**
Northern Rhodesia:					
Calcium ammonium nitrate	Negl.	Negl.	0.2	0.7	0.9
Sulphate of ammonia	1.7	1.9	1.1	0.7	0.9
Urea	0.2	0.7	1.0	1.1	1.2
Compounds	0.6	0.7	0.6	0.6	0.7
Total Northern Rhodesia	**2.5**	**3.3**	**2.9**	**3.1**	**3.7**
Nyasaland:					
Calcium ammonium nitrate	Negl.	Negl.	Negl.	Negl.	Negl.
Sulphate of ammonia	1.4	1.5	1.9	2.0	2.2
Urea	Negl.	Negl.	Negl.	Negl.	Negl.
Compounds	Negl.	Negl.	Negl.	Negl.	Negl.
Total Nyasaland	**1.4**	**1.5**	**1.9**	**2.0**	**2.2**
Federation:					
Calcium ammonium nitrate	0.6	0.6	1.4	3.7	5.4
Sulphate of ammonia	7.1	7.3	6.3	4.4	4.0
Urea	1.0	2.4	3.2	4.7	6.9
Compounds	3.9	4.5	4.7	5.0	6.2
Total for Federation	**12.6**	**14.8**	**15.6**	**17.8**	**22.5**

* These figures relate to sales of nitrogenous fertilizer by the three major companies and include direct imports of nitrogenous fertilizer to Nyasaland.

The three companies are African Explosives and Chemical Industries (Rhodesia) Ltd., Fisons Fertilizers (Rhodesia (Pvt) Ltd., and African Explosives which only produces superphosphates and compound fertilizers.

*Nitrogen 8, November 1960, P. 25 and 34.

Imports of Nitrogenous Fertilizers and Explosives to the Federation 1954-1960

Quantity (tons of 2,000lb.) and value f.o.b. £'000

	1954	1955	1956	1957	1958	1959	1960
Nitrate of soda	2,953	4,953	1,827	1,111	1,439	1,405	1,105
£'000*	51	98	30	24	24	22	17
Sulphate of ammonia	22,554	41,147	38,398	61,656	30,430	21,954	29,037
£'000*	374	718	667	722	393	257	292
Ammonium sulphate nitrate ...	N/A	N/A	5,405	10,523	11,824	6,019	9,725
£'000*	N/A	N/A	105	183	180	84	133
Urea	N/A	N/A	2,838	10,605	7,089	10,085	16,077
£'000*	N/A	N/A	97	363	237	273	430
Other (a)	N/A	N/A	1,792	2,429	5,766	21,542	26,366
£'000*	N/A	N/A	30	34	90	267	337
Total nitrogenous fertilizer ...	**N/A**	**N/A**	**50,260**	**86,324**	**56,548**	**61,005**	**82,310**
£'000*	**N/A**	**N/A**	**929**	**1,326**	**924**	**903**	**1,209**
Equivalent nitrogen	N/A	N/A	11,425	21,226	14,109	15,348	21,572
Blasting compounds	16,101	15,929	21,963	22,929	20,378	23,823	24,014
£'000*	1,257	1,216	1,628	1,751	1,520	1,750	1,874
Detonators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
£'000*	152	139	185	168	186	259	258
Fuses	1,144	1,165	1,261	1,494	828	1,065	1,204
£'000	356	380	426	533	344	436	458
Total	—	—	—	—	—	—	—
f.o.b. value £'000*	**N/A**	**N/A**	**3,168**	**3,784**	**2,974**	**3,348**	**3,799**

(a) Consists chiefly of calcium ammonium nitrate. * Value f.o.b. £'000.

integrated fertilizer and explosives plant in the Kafue Valley with production of ammonium sulphate on the Copperbelt as a by-product of mineral processing might be such as to allow nitrogen to be sold in Southern Rhodesia at prices no greater than if it were produced in a place situated in or adjacent to the main market.

Fertilizer industry located in Northern Rhodesia, however, would be less advantageous than one situated in Salisbury and much less favourable to supply Nyasaland's requirements.

Katanga Ministry of Agriculture has indicated recently that it would be interested in obtaining fertilizer requirements from the Federation.

Nitrogen from Oil Feedstock or Naphtha

A local company has been considering production of nitrogenous fertilizers in the Federation based on naphtha. This could reduce the cost of nitrogen by one-third. Naphtha could be obtained as a cut from the refinery to be built in the Federation. Additional crude oil would have to be imported and would result in additional residual oils for disposal. The refinery company would enter into a 10-year agreement with the Government to supply, if required to do so, oil feedstocks to a *Government-owned* nitrogenous fertilizer plant at 13d. per gallon *ex* refinery subject to changes in world prices. There is good reason to suppose, however, that the refinery company would quote the same prices to a privately-owned fertilizer plant.

Types of Fertilizer Required

If ammonium nitrate were made locally, the pattern of use based on the level of consumption of about 25,000 tons N, might be:—

14,000 tons nitrogen as ammonium nitrate, the bulk of this in the form of calcium ammonium nitrate.

2,000 tons nitrogen as ammonium sulphate; this might be superseded by an ammonium nitrate—gypsum mixture.

1,000 tons as urea for use with livestock.

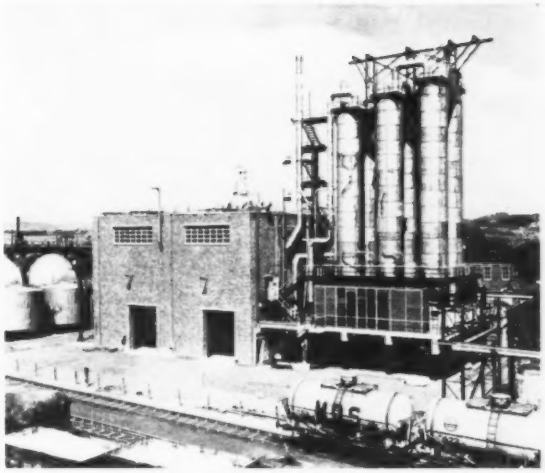
8,000 tons nitrogen for use in mixed fertilizer; the bulk of this would be ammonium nitrate, but 1,000 tons N might be required as ammonium sulphate.

Current Retail Prices in Salisbury

	Price per short ton	Equivalent price per short ton N
Calcium ammonium nitrate	£20 2s. 6d.	£ 98 3s. 3d.
Ammonium sulphate	£19 17s. 0d.	£ 94 10s. 2d.
Urea	£38 0s. 0d.	£ 82 12s. 1d.
Nitrate of soda	£30 11s. 6d.	£191 1s. 10d.
Overall average based on 1960 distribution of imports		£ 89 1s. 10d.

Mixed Pressure Nitric Acid Process for I.C.I.'s Ardeer Plant

Special features are efficient heat recovery and low catalyst losses



General view of I.C.I.'s Ardeer nitric acid plant showing the absorption towers and the ammonia storage spheres and nitric acid tanks

Of the present day commmercial processes for the manufacture of nitric acid, oxidation of ammonia using a noble metal catalyst, followed by absorption of the resulting oxides of nitrogen in water is by far the most important. An older process which is still used involves the reaction between sulphuric acid and sodium nitrate.

A process for making nitric acid by oxidation of atmospheric nitrogen has not yet proved successful in commercial application.

More recently, Rensselaer Polytechnic Institute has been studying oxidation of atmospheric nitrogen by passing air over glass fibres impregnated with radioactive uranium oxide. Behind these developments lies the need to obtain high process efficiency, with low capital costs and energy requirements per unit of acid produced.

In nitric acid manufacture by oxidation of ammonia there are two trends. In the U.S. most nitric acid is produced by the Du Pont process of oxidation of ammonia under pressure (8 atmospheres). This process basically requires considerable energy of gas compression but modern plant and equipment, i.e. rotary compressors and expanders has ensured high efficiency and lowered power requirements, as in the process developed by Chemical Construction Company (Chemico) and Chemical and Industrial Corporation.

Pressure conversion is accompanied by higher losses of catalyst than conversion at atmospheric pressure, although the greater part of the catalyst losses can be recovered by installation of filters.

In Europe, oxidation of ammonia at atmospheric pressure is favoured, as efficiency is high and use of large converters linked to waste-heat boilers keeps capital costs low and energy recovery high. Absorption of the nitrous gas to form the acid is carried out under pressure.

Dual-type Plant for I.C.I.

Imperial Chemical Industries' new 55,000 tons a year (100% HNO_3) plant at Ardeer, Scotland, is of this dual pressure type and has replaced three older units — a 1928 atmospheric pressure oxidation process and two Du Pont pressure oxidation plants of more recent construction which had an aggregate rated capacity of 40,000 tons a year. The new plant has been designed by Stamicarbon N.V. of Holland, and produces 60% nitric acid.

Ammonia Storage and Handling

Ammonia is brought to Ardeer by 12-ton rail tankcars from I.C.I.'s Billingham Division plant at Mossend, Glasgow, and stored in three 150-ton capacity (27ft. 6in. in diameter) Horton Spheres supplied by Whessoe Limited.

Compressors are used to pressurize the tank wagons when ammonia pressure is too low for discharge to the spheres. Kept at 0°C and 42 p.s.i.g. using recompression of flashed-off

gas, the spheres are mounted on Davy-United load wells which permit the contents to be measured at all times without the need for pressure volume corrections. Liquefaction equipment consists of three Veebloc 6-cylinder compressors, v-belt driven by 50 h.p. motors supplied by J. and E. Hall Limited.

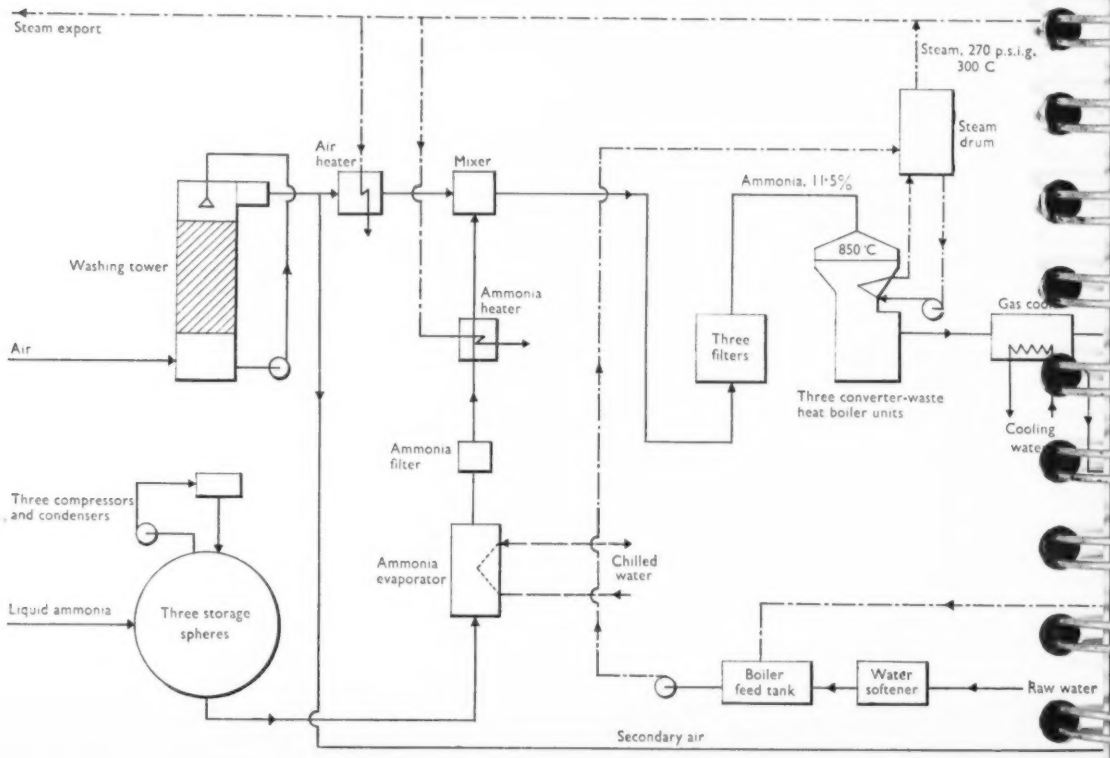
Instrument and electrical circuits are so arranged that the reactions start automatically in series as the ammonia pressure rises and cease as it falls.

Ammonia Vaporization and Mixing

Liquid ammonia is vaporized, heated, filtered and mixed in the correct proportions with primary air which has previously been washed and heated. The mixed gases containing up to 11.5% NH_3 by volume are filtered again, and are drawn through the system by the main compressor.

Air from atmosphere is water-washed in a 9ft. dia. Peabody scrubber after which the air flow is divided. The secondary air flow is led off through an 18in. diameter duct and rejoins the main process gas stream at the inlet to the compressor. Both streams are individually heated to 50° to 200°C before mixing. Primary air is heated, by condensing steam in a Weldex gilled-tube heater, and then passed through a length of straight 36in. diameter duct containing a metering orifice to the gas mixer, where it is joined by the ammonia stream.

A vertical tubular heat exchanger in which water flows through open-ended tubes to a drain tank below is used to vaporize the ammonia. As it enters the shell of the unit at storage pressure, liquid ammonia is let down almost to atmospheric pressure and is vaporized by heat exchange with water. Chilled water is circulated to the main plant for process cooling. Risk of freezing is avoided by the self-draining construction of the vaporizer and temperature controlled make-up water. Temperature of ammonia vapour is raised by



steam in the tubular exchanger and gas passes through a gas-mixer, through a 12in. pipe which contains a dead-weight operated trip valve to cut off the flow when a fault occurs, an auto-valve which controls flow in ratio to primary air, and a metering orifice.

The gas mixture is further cleaned before entry to the converters by a series of three units containing some 3,000 ceramic candle filters supplied by Aerox Limited.

A number of multi-nozzle mixers ensure homogeneity and a Cambridge recording catherometer continuously checks the gas.

The ammonia : air ratio controlling system is fully automatic and forms part of the elaborate control exercised over the whole plant operation. Careful control of flow rates, pre-heat temperature and ammonia : air ratio keeps the gauge temperature constant at about 850°C. Any desired catalyst temperature, which is also measured continously by a radiation pyrometer and recorded, may be achieved by adjusting the ammonia and air temperatures in the gas feed to the converters.

Ammonia Oxidation

Oxidation of ammonia takes place according to the reaction:—

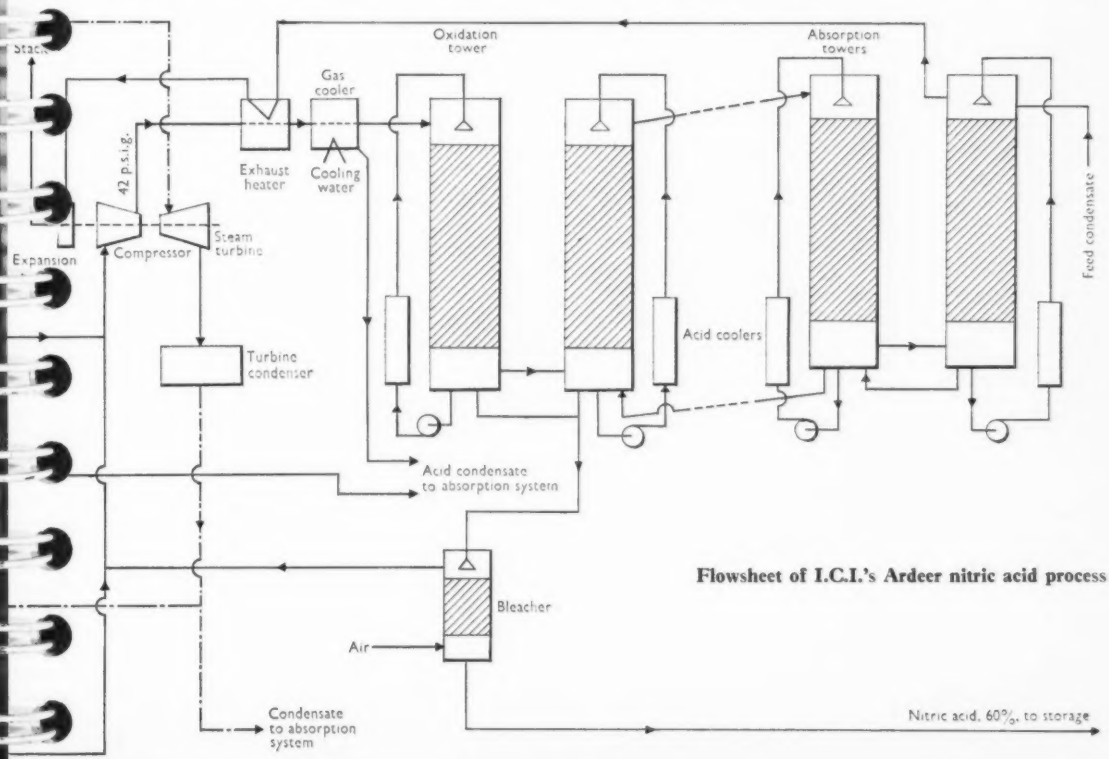
$$4NH_3 + 5O_2 = 4NO + 6H_2O$$

at high efficiency in three paralled converters, each employing three rhodium-platinum alloy gauzes 114 inches in diameter. The reaction takes place at one or two inches water gauge below atmospheric pressure.

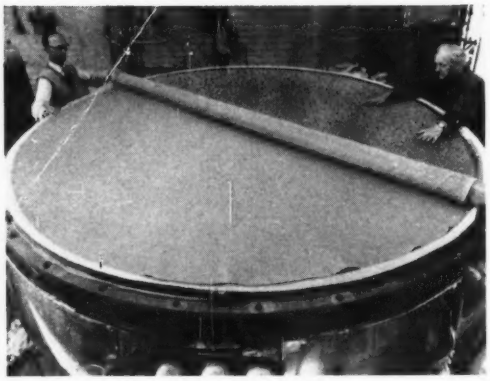
Catalyst for the Process

Platinum-rhodium alloys, being stronger at high temperatures than pure platinum, give high conversion efficiency with minimum loss of catalyst by erosion and volatilization.

The catalyst gauzes, woven of 0.06 mm diameter rhodium - platinum alloy wire by Johnson Matthey and Company Limited, are placed in a pad of three in each converter and are clamped in position using asbestos gaskets.



Flowsheet of I.C.I.'s Ardeer nitric acid process



The No. 2 converter being fitted with catalyst gauze supplied by Johnson Matthey Limited

The catalyst loading is 1 troy ounce of exposed platinum alloy for 140 lb. NH_3 burnt per day. A Nimonic grid supports the gauze pads above the waste boilers. Light-up of gauzes is effected by means of a hydrogen torch.

A conversion efficiency of 96% or better is possible, and an overall plant efficiency of over 94% is usually attained; at higher temperatures the rate of conversion is increased but this results in greater loss of catalyst. Conversion at atmospheric pressure, according to I.C.I., is generally more efficient than conversion under pressure; the estimated gain is 2% compared with conversion at between 1 and 7 atm. Catalyst losses at I.C.I.'s plant are expected to be very low — about 50 mg. per ton of nitric acid produced.

Converters

Plant throughput depends essentially on the compressor speed and pressure ratio.

The air-ammonia mixture enters the three converters at the top and flows downwards through conical hoods to the catalyst beds. Each hood is provided with three sight glasses, a port through which a torch can be inserted and an optical pyrometer. The hoods are not insulated, but are surrounded by sheet aluminum radiation shields for protection of personnel.

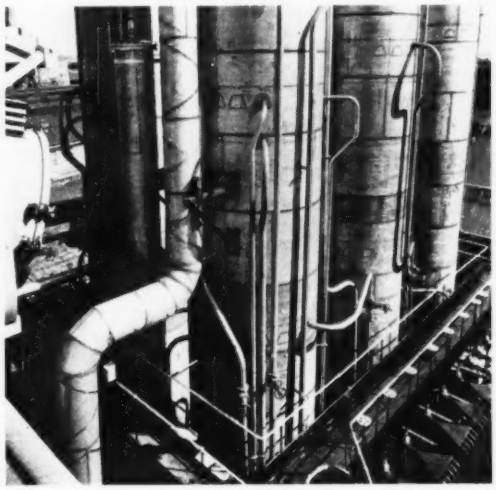
Efficient Heat Recovery

Efficient recovery of the large amount of reaction energy in the form of hot nitrous gas is a key feature of modern nitric acid plants. At the I.C.I. Ardeer plant, a La Mont forced-circulation boiler with super-heater and economizer designed and manufactured under licence by John Thompson Water Tube Boilers Limited, is placed immediately below each converter, making available a total of 15,000 to 20,000 lb./hr. steam at 300°C, 270 p.s.i.g. This steam provides two-thirds of the power requirements of the nitric acid plant.

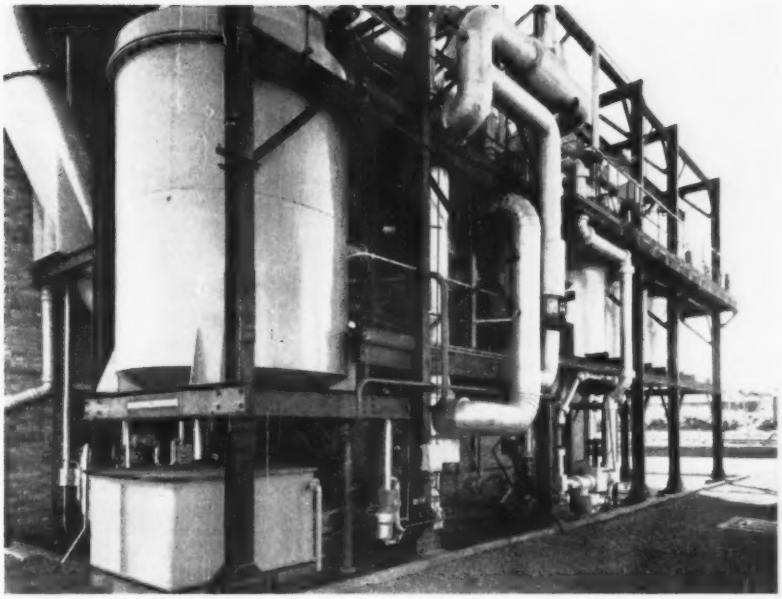
Part of the condensate from the steam turbine is used for nitric acid absorption, necessitating a fairly high proportion of make-up feed to the boilers. Incoming town's water passes through one of two base-exchange softeners to a tank which also collects condensate from the process heaters and surplus turbine condensate.

Nitrous gas leaving the boilers is drawn in a single pass through a cooler with multi-pass sections on the water side. Most of the water vapour formed in the ammonia combustion reaction is condensed and collected as very weak acid and pumped to the absorption system. At this point, secondary air rejoins the main process stream entering the compression.

The steam turbine-compressor-gas-turbine unit, with auxiliaries—supplied by Escher Weiss Limited — is a 6-stage centrifugal machine. At the high pressure end the shaft is extended beyond the journal bearing to carry a single-



Absorption towers showing acid pipework, acid coolers and bleachers



Peabody scrubber, ammonia pre-heater and mixed gas filters

stage gas turbine motor: at the low pressure end the compressor is coupled directly to the steam turbine which is a typical 12 - stage condensing machine with provision for steam extraction after the first two velocity stages.

No Ammonium Nitrate Deposition

Condensate can be sprayed into the compression inlet duct, or directly into the machine after the first and second steps. Washing action of the spray droplets reduces the risk of ammonium nitrate being deposited inside the machine. The heat of compression vaporizes the condensate so reducing power consumption by reducing the temperature rise of the gas. The gas turbine nozzle area can be carried with the gas rate enabling the absorption pressure to be maintained while obtimum power is recovered by the expansion turbine.

Speed of the set for flowsheet conditions is 5,850 r.p.m. and use of a steam turbine rather than an electric motor gives the plant considerable flexibility. When the set is on full load the gas turbine supplies about one-third of the power for the compressor.

Nitric Acid

Hot nitrous gas leaving the compressor passes through the shell side of the tubular heat exchanger, while cold tail gas from the absorption system flows through the tubes and is heated before entering the expansion turbine.

The nitrous gas is cooled and then passed through six towers 8ft. in diameter by 62 ft. high packed with stoneware Raschig rings. The towers are supported on three different levels on a reinforced concrete structure. In the first tower, the bulk of the nitric oxide to nitrogen dioxide oxidation takes place, and in the subsequent towers the fume is absorbed by the circulating liquor.

Elevated pressure at this stage promotes high efficiency, with a final stack loss of less than 2 grains of acidity per cubic foot.

Bleaching of Acid

Product acid, after pressure has been reduced to atmospheric, runs down over a ring-packed small tower in which it is bleached by a countercurrent air stream. The bleaching air is drawn through the tower by the main compressor.

The tower bottoms and the level tanks in the circulating systems of the separate tower sections are connected by balance lines. As the condensate for acid absorption is pumped into the last tower, which is on the highest level of

structure, acid of increasing concentration overflows from section to section and the final product is drawn off from the first absorption tower.

Acid from the towers is pumped by Worthington - Simpson centrifugal pumps through coolers, consisting of several stainless steel plate type elements in parallel, situated over tile-lined wells on either wing of the structure. Water drainage from them is piped to the cooling tower return pumps.

From there, the bleached acid is collected in four vertical cylindrical tanks each of 100 tons (100% HNO_3) capacity and mounted on load cells. From the storage tanks nitric acid is pumped to the respective sections of the works for end use.

Plant Construction

Mild steel is used for the ammonia sections of the Ardeer plant. The air scrubbing and heating section is also of mild steel, with parts in contact with wet air being protected by rubber or Calvinac linings.

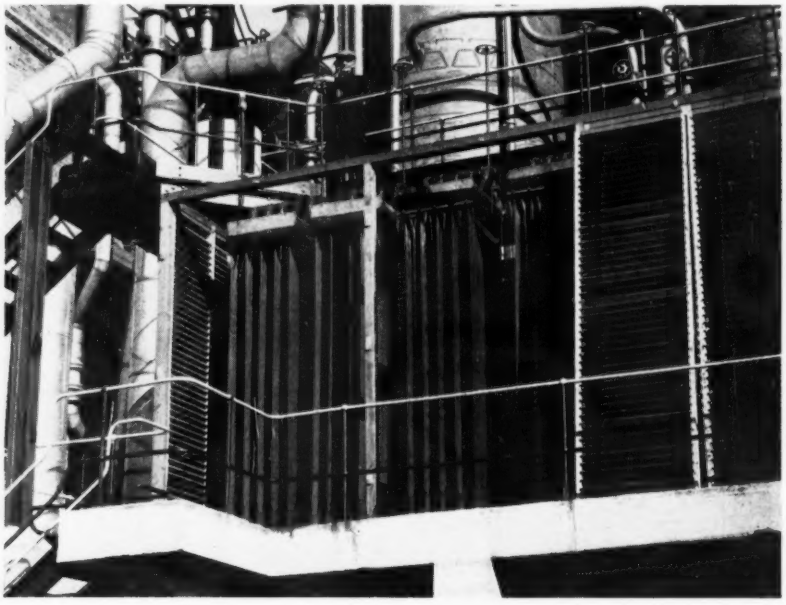
Stainless steel is used from the mixed gas filters to the converters — the parts supporting the catalyst gauzes are made of 18/10/Mo/Ti steel for strength. Waste heat boilers are of mild steel.

Parts in contact with weak nitric acid at moderate temperatures are composed of chromium-nickel austenitic stainless steel and for all parts where welding was required steel of 18/8/Ti composition with carbon content less than 0.06% has been used. For castings 18/8/Nb material has been used.

The compressor and expansion turbine have been constructed of 17% chromium and 1% nickel rustless irons.

Automatic Control

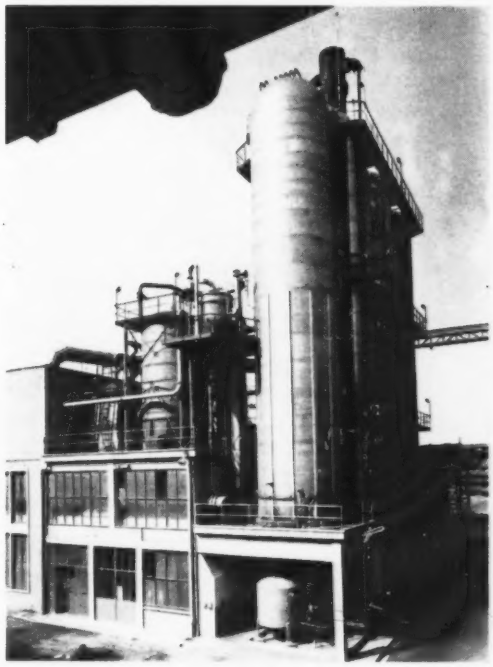
One of the notable features of I.C.I.'s new nitric acid plant is its very low requirement for operating labour. All flow rates, pressures and temperatures are automatically measured, recorded and controlled using indicators largely of Foxboro-Yoxall or Negretti and Zambra manufacture. Elaborate safety devices ensure rapid and automatic shutdown of the plant in the event of emergency. The efficiency of the gas cleaning systems completed with the very low loss of catalyst alloy, allows long continous operating runs, exceeding three months, to be achieved.



Nitric acid coolers and absorption system

Novel Absorption Oxidation Column for Nitric Acid Production

Kuhlmann process gives yeilds of 98% and HNO_3 of 70% Strength



The four nitric acid absorption columns at Ets. Kuhlmann's La Madeleine plant

USING a new advanced technique for producing nitric acid, Etablissements Kuhlmann of Paris, France, claims a reduced capital investment on plant, lower manufacturing costs, higher yields, and direct production of acid of 70% strength. The process is based on a novel absorption oxidation column and has been in operation since 1957 at Kuhlmann's La Madeleine-lez-Lille works in a 200-tonne-a-day plant. A large scale nitric acid plant which uses this new process has recently been brought on stream by Ashi Kasei K.K. in Japan.

Behind this development lies Kuhlmann's discovery that nitrous oxides reoxidizes almost instantaneously when mixed with air and bubbled through liquid nitric acid which is in equilibrium with the NO-rich gas. In conventional systems, this reoxidation takes place in the gas phase when air is injected into the vapour space above the liquid. The reaction is relatively slow and the vapour volume needed controls the size of absorption equipment to be designed. An absorption tower provides simultaneously oxidation of NO and absorption of NO_2 into weak acid with separate compartments on each tray. Each tray is divided into six triangular shaped compartments by separators. One or more of the compartments is formed by solid separators, while the others are bounded by separators perforated with slots at staggered intervals to allow mixing of the liquid as it flows from one compartment to the other around the plate.

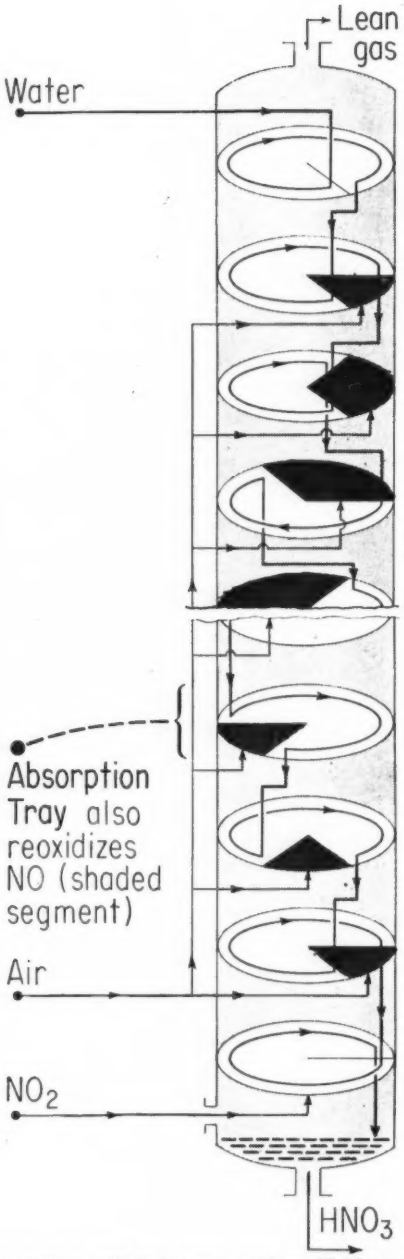
Three perforated diffusion boxes working like bubble caps allow the gas to pass from below through the liquid in each compartment.

Oxidation Zone

Isolated by solid separators, the compartments function as an oxidation zone. Acid contained in the compartment, which is in equilibrium with the $NO\text{-}NO_2$ stream from the next lower plate, is essentially stagnant. Along with $NO\text{-}NO_2$ (stream from the next lower plate is essential) air is introduced through the gas diffusion boxes, and to keep this acid cool to speed the oxidation reaction, are submerged brine-containing cooling coils.

Absorption Trays

Tray positioning for a typical 16-tray tower is as follows:—



Absorption oxidation tower used at Kuhlmann's La Madeleine nitric acid plant

Trays No. 2 to 7—starting from the bottom, each have one oxidation compartment, tray No. 1 being just a simple absorption tray. Each of the compartments, comprising one-sixth of tray surface, is offset at an angle to 60° from the oxidation zone on the tray below. The tray outlets are so arranged that the NO_2 enriched gas from the oxidation zone of the tower tray bubbles up through the most concentrated acid near the outlet on the next plate. It is this contacting of the most-concentrated acid with the most-concentrated gas that ensures maximum mass transfer through the gas liquid interface.

In the Kuhlmann column, plates 8 to 14 have two oxidation compartments — one-third of tray surface — also offset an angle of 60° in relation to the zone below. The partial overlapping so effected provides a double re-oxidation as the gas stream becomes more saturated in oxides of nitrogen. Tray No. 15, identical to trays Nos. 2 to 7 — completes the cycle of double oxidation and the final tray, No. 16, is again a simple, absorption tray.

The Acid Plant

The absorption oxidation towers are about 70ft. high and 15ft. in diameter. The rest of the nitric plant is based on standard nitric acid practice. Ammonia is oxidized catalytically at atmospheric pressure, with a waste-heat boiler and then through a heat exchanger. Cooled reaction gas containing oxides of nitrogen is compressed to about 40 p.s.i., further refrigerated and piped to the absorption oxidation columns.

Power Recovery

Compression of the gases before absorption reduces the size of the equipment needed and permits power recovery by exanding reheated gas through a turbine—an important

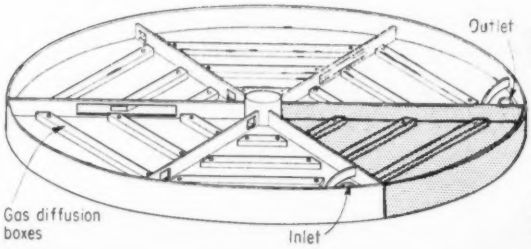


Diagram of a tray in the absorption tower which is divided into compartments

factor in reduction costs. The absorption pressure range is the same as that used in the Montecatini process.

Exhaust gases from the last absorption-oxidation tower are reheated in an exchanger, placed in front of the compressor and then expanded through a turbine connected to the compressor. A net power gain can be obtained because of the low pressure drop through the system of 7 p.s.i. for acid of 70% HNO_3 strength and 4.3 p.s.i. for 56% HNO_3 acid.

Advantages

Absorption efficiency since start up of the Kuhlmann unit in 1957 is reported to have averaged 99% compared with 95% in conventional plant. Acid strength of 70% is, of course, considerably greater than the usually obtained nitric acid 56-58% or of 60-62%, the higher concentration being obtainable if process efficiency is lowered. One of the main advantages of direct manufacture of nitric acid of 70% strength lies in the fact that in production of complex fertilizers less water has to be evaporated. Also significant economies result from the initially higher strength of the acid in manufacturing concentrated (98-99% HNO_3) acid. The merit of lower capital investment and manufacturing are self-evident.

Dry Bleach Market Potentialities of Chlorinated Isocyanuric Acids

U.S. producers of bleaches which are based on chlorinated isocyanuric acids and salts are hoping to make even deeper inroads into the $26 million dry bleach market, particularly in the industrial field. These compounds find application as swimming pool additives in industrial laundries and as detergent-sanitizers in dairies, hospitals, plants and other public places. It is hoped, however, that a dry household product based on chlorinated isocyanic acids can be developed for sale to soap manufacturers. Now producing isocyanuric acid compounds in the U.S. are Monsanto Chemical Company and Food Machinery and Chemical Corporation (F.M.C.), but almost any large nitrogen or chlorine producer could make the chemicals.

Monsanto began pilot-plant scale manufacture in 1953, and later began commercial scale production at Everett, Mass. The trade product is known as A.C.L. with 59, 60 and 70 and 85% available chlorine.

F.M.C. entered the U.S. market in 1960 with a six million lb. plant at South Charleston. The unit has been operating since October last year, producing isocyanuric acids and salts which are designated C.D.B. Expected to enter this field in the near future is Olin Mathieson Chemical Corporation.

Consumption of chlorinated isocyanuric acids and salts in the U.S. is currently estimated at well over six million lb. annually and Industry capacity is estimated at 14 to 15 million lb. In the U.K. sales amount to just over 1 million lb. a year, the material being available from imports by Monsanto Chemicals Limited, London. Under construction at the Loughborough works of Whiffen and Sons Limited, one of the Fison group, is a £100,000 plant to make 350 tons a year each of cyanuric and trichlorocyanuric acids. Output will be sufficient to enable Whiffen to meet all U.K. needs and to provide a surplus for export. Provision has been made for expansion of output as necessary.

Whiffen to produce in U.K.

At present the only other U.K. producer is Cocker Chemical Company Limited. Supplying Western Europe is Farbenfabriken Bayer, A.G. of Leverkusen. Sales in Europe at present are small — estimated at 448,000 lb.

Advantages of the isocyanurics are that bleaches containing them offer a bleaching effect approaching the low-cost of inorganic hypochlorites but with less tendency to weaken fabrics. As swimming-pool additives they provide a source of available chlorine less susceptible to dissipation by sunlight. At present a higher price than other bleaches is holding back sales, but if allowance is made for convenience in its use and ease of handling as well as the bleaching properties of these isocyanurics, the market potential for them can be expected to expand rapidly.

Fisons to be the Second Largest Nitrogen Producers in the U.K.

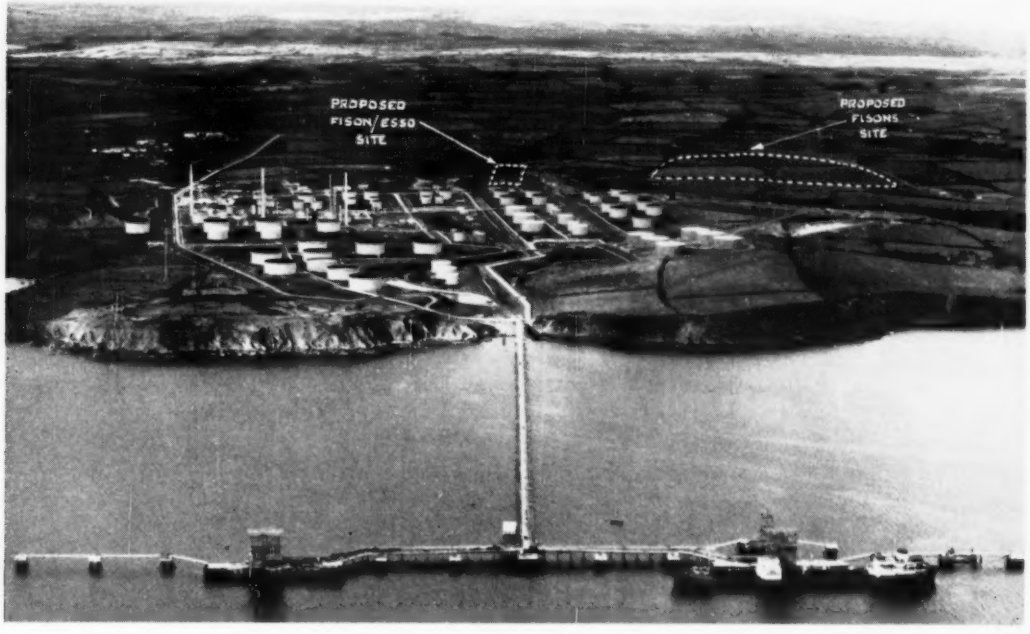
£14 million ammonia and nitrogen products expansion programme, partly in conjunction with Esso Petroleum

IMPORTANT developments of Fisons Limited's nitrogen interest which were foreshadowed by the company's chairman, Sir Clavering Fison, late last year, have now been outlined. As indicated in the last issue of NITROGEN*, site of the new ammonia and nitrogen complex will be Milford Haven. Fisons is forming a joint company with Esso Petroleum Company Limited, on a 50-50 basis, to produce 150,000 tons ammonia (124,000 tons N) a year, on a five-acre site adjacent to Esso's oil refinery at Milford Haven in Pembrokeshire, Wales. Cost of the new plant will be about £4 million, and it is due on stream in Spring 1964.

On a separate 40-acre site near the ammonia plant, Fisons will also construct a new, wholly-owned nitrogen plant for the manufacture of intermediate and final fertilizer and chemical nitrogen products for sale, at home and overseas.

In addition to the developments at Milford Haven Fisons plans to expand capacity of the synthetic nitrogen plant at Flixborough in Lincolnshire which Fisons Fertilizers Limited owns jointly with West Norfolk Farmers Manure and Chemical Company, of King's Lynn. Rated capacity of the existing plant is about 13,000 tons N and, when the plant expansion is completed, will be more than doubled.

Contract for the new synthetic ammonia plant at Flixborough has been awarded to Chemical Construction (G.B.) Limited,



Milford Haven from the air showing the existing refinery of Esso Petroleum and the proposed sites for the Fisons/Esso ammonia plant and the new nitrogen factory of Fisons

* Nitrogen No. 10, p.22

London. The plant will be sited adjacent to the existing unit. Raw material will be hydrocarbon gases from the nearby steel works at Scunthorpe. Output of ammonia from the new plant, on which construction work has started, will be delivered to Fisons Fertilizers and West Norfolk Farmers.

On Stream Date

Installation of the new plants at Milford Haven and Flixborough, which will be in commission by Spring 1964 and 1962 respectively, is estimated to cost £12 million, the major part of which will be met from the company's existing and accruing resources.

Work will start shortly on the joint Esso-Fisons ammonia plant, which will be constructed in accordance with a mutually agreed specification and programme, with Esso acting as managing agent. Esso will also be responsible for operating this new plant on behalf of the joint company. Tenders have been submitted by various construction companies. It is expected that steam reforming will be employed for production of synthesis gas from the refinery gas.

Ammonia for the N Complex

Ammonia produced at the joint Esso-Fisons plant will be piped to the adjacent Fisons complex for manufacture of nitrogen fertilizers and products. The greater part of the ammonia output at Milford Haven will be converted to nitrogen fertilizers to meet the needs of the home markets and to suit overseas markets.

Whiffens Limited, another member of the Fisons Group, manufacture among a range of fine chemicals, substantial quantities of hydrazine and Genitron, a foam blowing agent, dimethylol ethylene urea and others. It is these latter fields which have shown notable expansion in the last few years. Whiffens also has interests in plastics.

Esso's First U.K. Chemical Venture

The joint Esso-Fisons venture represents Esso's first entry in the U.K. into chemical manufacturing. The Milford Haven plants will be the first petrochemical projects to be established in this new oil refining area and will provide employment for some 250 people.

Control Over Costs

These new ammonia and nitrogen projects will make Fisons the second largest nitrogen producer in the U.K. At present Fisons purchases the bulk of ammonium sulphate requirements from I.C.I. and also buys ammonia and part of its nitric acid requirement for 400 tons-a-day ammonium nitrate plant at Stanford-le-Hope plant from the Shellhaven plant of Shell Chemical Co. Limited. By making its own ammonia Fisons can obtain more effective control over its manufacturing costs.

Recently Mr. W. J. V. Ward, Chairman, I.C.I.'s Billingham Division, commenting on the company's scheme to spend more than £6 million on modernizing Billingham by replacing coke-ovens and other large plants making synthesis gas for ammonia production* said that besides assuring supplies, other factors, such as I.C.I's ability to compete successfully in the future, have had to take priority.

U.K. Nitrogen Production

The bulk of the U.K.'s ammonia is manufactured by Imperial Chemical Industries Limited—estimated to have installed ammonia capacity of 475,000 tons N at five plants — and until the entry into this field of Shell Chemical Co., I.C.I. enjoyed a virtual monopoly in synthetic ammonia manufacture. The Shellhaven ammonia plant which came on stream early in 1959 with a rated capacity of 75,000 tons p.a. NH_3, has since been expanded to 84,000 tons NH_3, but actual output has remained substantially below this level.

At present U.K. synthetic ammonia capacity is estimated at 557,000 tons N and production in 1960 is estimated to have totalled 515,000 tons N augmented by 60,000 tons N of by-product sulphate of ammonia. Of the total nitrogen output, fertilizer nitrogen in 1960 represented 425,000 tons N and this year total output is expected to rise to 600,000 tons N.

By 1965 with the completion of Milford Haven and Flixborough projects and I.C.I.'s 100,000 tons NH_3 ammonia plant at Severnside, synthetic nitrogen capacity in the U.K. will be about 775,000 tons N.

* Nitrogen No. 10, 1961, p.32

Nitrogen Consumption at New Peak

HEAVY world-wide demand for fertilizer nitrogen during the spring season, coupled with the rapidly increasing technical uses of nitrogen in all industrial countries, is exerting strong pressure on available supplies. After a promising start, N consumption in the current fertilizer year received a severe setback almost throughout the world during the latter part of the autumn of 1960. Adverse climatic conditions in Europe, recession in the U.S. economy, natural disasters in China and a miscellany of factors in many other overseas markets, checked the rate of expansion of recent years and caused considerable anxiety among the major world exporters. From January onwards, however, export and domestic markets rapidly improved and demand built up so much that there are virtually no spot supplies available, and forward sales reach well into mid-summer. It is estimated that world consumption of fertilizer nitrogen will total at least 10.9 million tonnes N and together with technical nitrogen use of 1.9 million tonnes N will equal, if not slightly exceed, production. A contributing factor to the current tight supply situation was the slowdown in the rate of world nitrogen production which was in evidence in the early months of 1961.

Firmer Prices

The incidence of high prices in domestic markets, notably in Europe where seasonal rebate systems operate, and the tight world supply situation, have contributed to the firm tone of markets and prices. In export markets there has been no significant change and the bulk of the trade continues to be executed within the fairly narrow limits at prices corresponding to $26 to $32 per tonne ammonium sulphate bulk f.o.b. Western Europe. China secured additional tonnage at the same rigorous prices at which she purchased in December.

The main effect of the tightening supplies has been primarily to remove signs of weakening prices which had become apparent in several quarters. In respect of urea this sentiment is still in evidence and world prices to-day are lower than a year ago.

New Capacity

Apart from the steady progress in plant construction and the advancement of new projects in underdeveloped and lesser industrialised countries, recent months have seen striking developments in the expansion plans of several major nitrogen producing countries.

In the U.S.A. a series of announcements of new projects with early completion dates corroborate the views expressed in December 1960 by Mr. Riley, president of Southern Nitrogen Company . . . "Construction of new ammonia capacity cannot be delayed if serious shortages are to be averted."* At present installed capacity in the U.S.A. is 5.2 million short tons ammonia, and this is likely to increase on present indications by at least 800,000 short tons by the end of 1962.

In France the rate of new construction appears to be speeding up as it is reported that installed capacity of 1.4 million tonnes N may be available by 1963 and not by 1965/6 as previously planned.

In the U.K. the decision by Esso Petroleum Company and Fisons Limited to build and operate jointly a 150,000 tons a year ammonia plant will raise U.K. installed capacity to about 780,000 tonnes N by 1965.

Embodying improved production techniques, which plant and equipment constructors are bringing forward constantly, the additions of new plants promise not only a possible reduction of the cost of nitrogen as plant food and industrial raw material, but also a better return to the enterprising producers.

* Nitrogen No. 10, March 1961, p.35

SUPPLY

U.S.A.

Strong demand is making heavy calls on all suppliers, especially of ammonia, solutions and ammonium nitrate. Ammonium sulphate remains in very short supply, in part because the steel industry is still working at reduced levels, but also because the prevailing price does not offer sufficient inducement to synthetic ammonium sulphate producers to augment output. Sales of fertilizer urea have advanced significantly following the price reductions earlier this year. This applies especially to urea solutions which, incidentally, held their price.

Urea demand this year is expected to rise to 700,000 tons compared with about 570,000 tons in 1960 of which 370,000 tons was used as fertilizer. Three new plants are due on stream in 1961, which will bring installed capacity to about 990,000 short tons urea. At the same time urea imports remain high—on average 7,100 short tons each in November and December 1960.

Rise in Production

In January 1961 U.S. production rose to 410,300 short tons NH_3 3½% more than in January 1960. Since then monthly output of ammonia is reported to have risen to a new peak level of 440,000 s. tons. Ammonium sulphate output in January totalled 101,900 short tons, including 44,900 short tons by-product material. At this level, which appears to have continued throughout the spring, output is little over one-half the production in 1959 prior to the steel strike. Imports in January rose to 22,800 short tons. Fertilizer supplies in 1960-61 are expected by U.S. Department of Commerce to rise 4% to 2,946,000 short tons N. About 60% is expected to be ammonia, ammonium nitrate and their solutions with urea.

Anhydrous ammonia for direct application is expected to rise 6%. Exports of N fertilizer are expected to be 40% higher than in 1959-60, while imports may double. The favourable forecast is based on rising consumption trends, supported by farmers' greater spending power coupled with the realization of the advantageous economics of greater fertilizer application.

New Plants

Shamrock Oil and Gas Corporation (Amarillo) plans to build a 150 short tons a day NH_3 ammonia plant at Dumas, Texas, adjacent to the company's McKee oil refinery. This will be the company's first chemical venture.

W. R. Grace and Company plan to build a 60,000 short tons a year NH_3 ammonia plant at Big Springs, Texas, adjacent to the Cosden oil refinery in which Grace hold a 53% interest. The new plant is intended to meet rising demand in West Texas.

The Morgantown, W. Va., ordnance works built at a cost of $64 million, now idle, will be purchased, subject to Government approval, by Deuterium Corporation of New York at a price of $1.5 million. Initially, ammonia, methanol and formaldehyde and also urea, nitric acid and ammonium nitrate, are to be produced. Instead of coke-oven gas ammonia is to be synthetised from natural gas.

Diamond Alkali Inc. is expected to start ammonia production at Deer Park, Texas, in early 1962. Output is to be marketed by Monsanto.

Tenneco Chemical Co., a subsidiary of Tennessee Gas Transmission Company, is considering ammonia production on the Houston ship canal, using by-product hydrogen from an acetylene plant and nitrogen from an oxygen plant. Texaco Inc. has completed an expansion of its ammonia facilities at Lockport and installed capacity has been increased from 180 to 220 short tons a day by the addition of compressors and modification of existing process requirements.

WESTERN EUROPE

Strong domestic demand coupled with high export sales is straining the resources of most suppliers. An important factor has been the additional purchase by China, reported at 400,000 tonnes, which raises the total 1960-61 West European exports to this key market to 1.15 million tonnes ammonium sulphate and lime ammonium nitrate.

United Kingdom

Deliveries of nitrogen fertilizer to distributors and farmers during the past months are reported to be at a new peak and it is expected that despite the adverse demand of last autumn, consumption in 1960-61 may after all exceed last year's record. Apart from the imports by Shell Chemical Company of lime ammonium nitrate (Nitra-Shell) and complex fertilizers from its associates in Holland, the level of imports into the U.K. has declined steeply, in particular of ammonium sulphate, and imports are represented primarily by ammonium nitrates, ammonium phosphates and small quantities of urea.

Production this year is expected to total 600,000 tons N, including 440,000 tons N fertilizer nitrogen. The recently announced Esso-Fisons ammonia project and Fisons' projected fertilizer and technical nitrogen plant, both at Milford Haven (see Page 22), coupled with the expansion of capacity of the Flixborough plant of Nitrogen Fertilizers Limited, will raise U.K. synthetic ammonia capacity by 25% to about 700,000 tons N by 1964. The completion of the Severnside project of Imperial Chemical Industries Limited by 1965, together with the modernisation of some of the existing I.C.I. synthetic nitrogen facilities, will re-establish the status of the U.K. nitrogen industry among Europe's leading producers and provide a surplus of nitrogen fertilizer and technical products for export. In the meantime, I.C.I. is expanding alkylamine facilities; in particular, the capacity of methylamines is to be increased fivefold by 1963. At present it is the only producer of these products at two plants with an aggregate capacity of 2,000 to 3,000 tons a year.

West Germany

Synthetic ammonia production during the first two months of 1961 totalled 216,000 tons N. Nitrogen fertilizer output in this period was at the high level of 192,800 tons N; exports rose to 109,100 tonnes N, but domestic sales were still slow at 79,900 tonnes N. Stocks at the end of February of 171,300 tonnes N were 50,200 tonnes N higher than a year earlier. Mounting industrial demand is reflected by the technical nitrogen output of 41,700 tonnes N.

Matthias Stinnes AG. reports synthetic ammonia output of 90,000 tonnes NH_3 for 1960 compared with 53,000 tonnes in 1959.

Farbwerke Hoechst AG. reports increased fertilizer sales in 1960 at lower prices than in 1959. Fertilizer sales represented only 10.5%, compared with 12% in 1959, of turnover which had risen 21.7% to DM 2,703 million. The company's fertilizer export sales organisation is being regrouped by geographical divisions. At the Knapsack Griesheim AG. subsidiary's works a new rotary furnace for calcium cyanamide is being installed.

Netherlands

According to the Dutch Economic Plan for 1961 synthetic fertilizer production is to rise by 6% — the same as 1959 — whereas exports are to rise 8% compared with an increase of 3% in 1960.

France

Production of synthetic ammonia in the first quarter of 1961 totalled 207,200 tonnes N, over 26% greater than in the same period of 1960. In March production rose 12½% to 73,100 tonnes N, representing an annual rate of 877,000 tonnes. Nitrogen fertilizer production in the first quarter of 1961 totalled 167,400 tonnes N. Following the expansion of capacity of the St. Benoit de Carmaux plant of Houillères du Bassin d'Aquitaine to about 30,000 tonnes N a year, output of lime ammonium nitrate (20.5% N) has been increased since the beginning of this year from 125 to 440 tonnes per day. The expansion was originally scheduled for completion in 1962.

Soc. Toulousienne de Produits Chimiques "Tolochimie," a new company and subsidiary of Rhône-Poulenc and Usines de Melle, with a share capital of NF6 million, is building a Toluene diisocyanate plant Toulouse.

Italy

Production of nitrogenous fertilizers in 1960 reached a new peak of over 660,000 tonnes N, including 264,000 tonnes N ammonium sulphate, 170,000 tonnes N ammonium nitrates and 44,800 tonnes N urea. Output of complex fertilizer rose to 828,700 tonnes.

COMMUNIST COUNTRIES

U.S.S.R.

Synthetic fertilizer production (NP and K) in 1960 totalled 13.8 million tons, 7% greater than in 1959.

At Grodno in White Russia one of the biggest nitrogen plants in the U.S.S.R. is projected, and the first phase is to come on stream in 1963.

Poland

Ternary complex fertilizer manufacture is reported to have started at the Heydebreck chemical combine, where installed capacity is 180,000 tonnes N a year.

CENTRAL AND SOUTH AMERICA

Mexico

Cicloamidas SA., a new subsidiary of three synthetic fibre producers, plans to build an 8,000 t.p.a. caprolactam plant by 1963. By-product ammonium sulphate can be expected to be at an annual rate of up to 30,000 tonnes.

Uruguay

Credit of U.S. $12 million has been granted by the Italian Government to the Administracion Nacional de Combustibles Alcohol y Portland for a fertilizer plant project for which Soc. Montecatini is reported to have shown interest.

MIDDLE EAST AND FAR EAST

India

Domestic production in 1960 is estimated to have risen to about 120,000 tonnes N. At the same time imports by the Government of India are being maintained at a high level and in 1960-61 are expected to total 110,000 tonnes N. The Government of India, whose current 5-year-plan provides for the establishment of one major N-fertilizer plant in each state, may receive a loan from Japan under her aid programme for India, to build a 150,000 tonnes a year urea plant in Uttar Pradesh, in North-West India. Kobe Steel Works, Mitsubishi and Chiyoda Kako Kensetsu, a construction company are reported to be interested in executing the project.

The 50,000 tonnes a year ammonium phosphate plant of East India Sugar Distilleries at Ennore is due on stream by mid-1962. The company is also associated with the project of International Minerals and Chemicals Corporation, of Skokie, U.S., in a major project at Vizagnapatam, where production is likely to include ammonium phosphates.

Commenting on India's fertilizer programme, Professor Ewell, of the University of Buffalo, is reported to have put forward the view that the main expansion should be in the production of ammonium phosphates, in particular of ammonium sulphophosphates (16-20-0).

Pakistan

Under three procurement authorisations with a total value of $6.93 million issued by I.C.A. for nitrogenous fertilizers to be shipped between 1 May 1961 and 28 February 1962, the Pakistan Government has called for tenders in respect of 46,000 tonnes of urea and 15,000 tonnes ammonium sulphate, plus urea to the value of funds left out of $2.32 million after the purchase of ammonium sulphate, probably about 12,500 tonnes. In addition to the I.C.A. tenders the Government of Pakistan will seek world-wide offers in respect of 30,000 tonnes urea to be purchased with its own funds.

Thailand

The Lignite Thermal Authority is reported to be planning a nitrogenous fertilizer plant based on lignite and is hoping for World Bank support for the project.

Nitric acid manufacture is about to be started by Siam Chemicals Company at Bangkok, based on sulphuric acid supplies from the company's new 10-tons-a-day (100% H_2SO_4) plant.

Philippines

Atlas Fertilizer Corporation has announced that the company's products range now includes commercial quantities of crystalline monoammonium phosphate.

Indonesia

The 100,000 tonnes a year urea plant project from which Foster Wheeler Inc. withdrew late last year, is now to be executed by Morrison-Knudsen International Constructors

Inc., of San Francisco. To be built on the Musi River near Palembang, Sumatra, and based on natural gas, the $38 million project will be financed by the Export/Import Bank. (See also Page 45).

At present the Government trading organisation, Mira Sari, is seeking offers for 74,000 tonnes urea and 125,000 tonnes ammonium sulphate. In recent weeks, Norsk Hydro is reported to have shipped some 5,000 tonnes urea as a part cargo combined with U.K. triple superphosphate.

China

Purchases in Western Europe to date for import during the current fertilizer year appear to total some 245,000 to 250,000 tonnes N but it is not expected that total imports in 1960-61 will reach 300,000 tonnes N. Domestic fertilizer production is receiving high priority and may rise this year to 250,000 tonnes N.

Japan

According to recent reports, the Japanese nitrogen fertilizer industry expects to fulfil its export targets for 1960-61. Sales to the end of April are said to total some 690,000 tonnes ammonium sulphate, including 160,000 tonnes to private traders in South Korea against I.C.A. funds, and 110,000 tonnes to Taiwan. The latter is expected to buy up a further 70,000 to 100,000 tonnes ammonium sulphate, which could raise sales close to the export target of 810,000 tonnes. Sales earlier this year of urea to Pakistan (10,000 tonnes), India and to South Korea (70,000 tonnes) are reported to have brought the volume of sales to 210,000 tonnes, against the industry's target figure of 276,000 tonnes.

EXPORT PRICES

Apart from the major sales by West European producers to China, which are being executed at similar prices—corresponding to $30.80 per tonne ammonium sulphate f.o.b. in bags—as the sales last December, export prices have shown a firmer trend, as the result of the tight supply position. This development draws attention once more to the inadequacy of storage facilities, which in Western Europe estimated to be adequate for no more than 45 days' production and which are the primary cause of the fluctuations of producers' sentiment as to the relation of supply and demand and of the recurring recourse to distress sales. At present the satisfactory sales picture forward to mid-summer points to firm prices prevailing, but already the uncertainty of export demand later in the year appears to be raising anxieties.

Ammonium sulphate

Export prices range from $26-$32 per tonne f.o.b. in bulk in Western Europe. U.S. material, if available, is offered at domestic prices, and in Japan exports are priced at $39.50 to $41.80 per tonne f.o.b. in bulk.

As the result of the firmer price tendency, the majority of recent sales from Western Europe of ammonium sulphate in bags appears to have been transacted at $33 to $37 per tonne f.o.b.

Ammonium Nitrate

Current quotations for ammonium nitrate (34% N) range from $58 to $63 per tonne f.o.b. in bags. Substantial quantities of material from Bulgaria and U.S.S.R. appear to be on offer within the price range.

Lime Ammonium Nitrate

The level of export prices of lime ammonium nitrate (20.5% N) from Western Europe remains consistently below that of ammonium sulphate at a differential of 4s. to 7s. per tonne ($0.56 to $1.00). Export prices range from $26 to $32 per tonne f.o.b. in bulk.

Urea

The substantial world-wide increase in plant capacity and output has depressed the price level of urea. Recent quotations in Western Europe are consistently in the lower part of price bracket of $76 to $80 per tonne f.o.b., whereas quotations from Japan are reported within a wide bracket of $76 to $90 per tonne f.o.b.

In a recent review of export activities by I.C.I. reference was made to the loss of markets for urea owing to inability to compete.

DOMESTIC PRICES

Domestic price listings remain unchanged.

U.S.A.

Anhydrous ammonia prices on the East Coast, South, Mid-West and North Central States, remain at $92 per short ton *ex* works. On the West Coast dual pricing—$92 and $66 to $72 per short ton *ex* works—continues. Urea prices along the East Coast are now stabilised at their lower level, urea in solutions does not appear to have been affected by the price cut.

U.S. Prices

Ammonium sulphate	
Coke oven	$32 per short ton, in bulk, f.o.b. works
Synthetic	$35 per short ton, in bulk, f.o.b. works
Ammonium nitrate	
Fertilizer grade (33.5% N)	$67 per short ton, in bulk, f.o.b. works
Fertilizer grade (20.5% N)	$48 per short ton in bags ex-works
Urea*	
Fertilizer grade (45% N)	$86 per short ton, in bulk, f.o.b. works $92.50 per short ton, in bags, f.o.b. works
Feed grade	$95 per short ton, in bags, f.o.b. works
Industrial grade (46% N)	$100 per short ton, in bags, f.o.b. works
Nitrogen solutions (40.8% N)	$164 per short ton (100% N) tank cars ex-works
Anhydrous ammonia	
Fertilizer grade	$92 per short ton, tank cars, ex-works
Refrigeration grade	$94.50 per short ton, tank cars, ex-works

United Kingdom
(d/d farmer's nearest railway station per ton)

	£	s.	d.	Subsidy £	s.	d.
Nitrate of soda (16% N) d/d	24	3	0	7	4	0
Sulphate of ammonia (21%) d/d	21	0	0	9	9	0
Nitrochalk (15.5% N) d/d	18	5	0	6	19	6
(21% N) d/d	23	11	6	9	9	0
Nitra-Shell (23% N) d/d	25	16	6	10	7	0

France
(New Francs per 100 kg. in 20 tonne lots)

		February to May 1961 without taxes	with taxes
Ammonium sulphate	20% N	24.70	27.44
	20.60% N	25.41	28.23
	21% N	25.88	28.76
Urea (prills)	45%	53.92	59.91
	46%	55.12	61.24
Lime ammonium nitrate (ammonitrate)	20.50%	23.92	26.58
	27.50%	30.75	34.17
	33.50%	35.38	39.31
	34.00%	35.96	39.90
	34.50%	36.44	40.49
Calcium nitrate	15%	23.11	25.68
	15.50%	23.88	26.53
Calcium magnesium nitrate		21.86	24.29
Ammonium nitrate	33.50%	34.35	38.17
	34.50%	35.38	39.31
	34.90%	35.79	39.77
Sodium nitrate	16.00%	27.76 28.12	30.84* 31.24†

* February † March-May

* W. R. Grace & Company announced on May 29th that as from July 1st fertilizer grade urea prices would be raised by $2 and feed grades and industrial grades by $3.

West Germany
(per tonne N)

	Feb.-June
Ammonium sulphate nitrate (26% N)	DM 1,150
Ammonium sulphate (21% N)	DM 1,140
Calcium ammonium nitrate (20.5% N)	DM 1,175
Urea (46% N)	DM 1,090
Calcium nitrate (15.5% N)	DM 1,330

Italy
March-June 1961

Ammonium sulphate (20-21% N)	Lire 3250 per 100 kg.
Lime ammonium nitrate (20.5% N)	Lire 2820 per 100 kg.
Lime ammonium nitrate (26.5% N)	Lire 3460 per 100 kg.
Calcium nitrate (15.5% N)	Lire 3130 per 100 kg.
Calcium cyanamide (20 to 21% N)	Lire 3720 per 100 kg.

Belgium (B.Frs. per 100 Kgs.)

	Ammonium Nitrate	Ammonium Sulphate		Perlamide	Cyanamide	
	22.5% N	20.5% N	20% N	18% N	18% N	22% N
March	225	236	228	349	326	379
April	255	236	228	347	326	379
May	255	238	230	347	326	379
June	257	238	230	347	326	379

Spain

The current domestic prices quoted by leading producers are as follows :—

Ammonium sulphate	Pesetas 2982-3050 per tonne ex-works in bags ($49.50-$50.60)
Lime ammonium nitrate (20.5% N)	Pesetas 3295-3337 per tonne ex-works in bags ($54.65-$55.30)

Farmers' prices are augmented by transport charges and retailers' margins.

Freights

Tight Supply Situation for Conventional Tramp Ships

ALTHOUGH the Peoples' Republic of China now has control of an enormous flotilla of timechartered tonnage, estimated at between 1.5 and 2 million deadweight cargo tons capacity, this is evidently far from sufficient to meet her present shipping needs, aggravated as they are by last year's crop failures at home. Among the commodities for which she has specially sought the assistance of the open charter market nitrogenous fertilizers are prominent; but, unlike some other trades, notably sugar from Cuba, where very high freights have had to be offered in order to attract ships, a heavy programme of ammonium sulphate bookings has gone through, so far, without greatly disturbing the market. Current freights from Northwest Europe at about 64s. 0d. a ton basis South Chinese ports and 59s. 6d. from the Italian Adriatic, are on a par with those paid in the Spring of 1960.

India, despite heavy liftings of imported fertilizers in the growing merchant fleet under her own flag, at present shares with China the leading position in tramp ship charterings. Freight rates for main ports in India or Pakistan now stand at around 48s. 0d. a ton on f.i.o. terms from Antwerp/Hamburg, at 41s. 0d. from the Adriatic and 1s. 6d. less from Priolo. Fixtures made on liner terms discharging, under which in addition to paying the cost of stevedoring the shipowner also accepts the risk of time lost in port, rates are 10s. 0d. a ton higher.

Parcels of urea are often included, together with ammonium sulphate and/or nitrate in tramp ship full cargoes to India and brokers' lists are now quoting a fair number of full cargoes of urea only from the Near Continent and also one of 8,000 tons from Heroen. This is disadvantageous to buyers from the freight angle, because most ships can load 1,000-2,000 tons of urea without cutting the total weight of cargo carried, making up the balance with sulphate; if urea, which stows about 62 cubic feet to the ton, is shipped in full cargoes this entails a loss of about 20% in the deadweight carrying capacity and a consequently higher freight per ton.

* Nitrogen 8, Page 25

In Western Europe many small ships in the 2,000 to 4,000 tons class have been fixed from Germany and the Low Countries to Spain and Portugal, freights for ammonium sulphate in bulk remaining at around 21s. 0d. a ton f.i.o., with 1s. 6d. extra quoted for North France loadings.

Other recent charterings out of France include a 6,700 tonner from Dunkirk to Turkey with sulphate and two ships each 10,000 tons from the same loading port to South China. Like so much traffic into and out of France, however, details of freights paid remain unknown. In respect of the recent numerous freight enquiries for West Coast of South America the Japanese appear to have had some success, evidenced by the booking of a 10,000-ton vessel from one port in Japan to three ports in Peru, to load a full cargo of urea in bags at a freight of $7.50 per ton f.i.o.

Soviet charterers invite offers for a full cargo of sulphate from the Black Sea to Haiphong. Westward across the Atlantic $5.50 a ton is quoted, also for sulphate, from Porto Marghera to Houston and New Orleans. Of considerable interest is the very high rate of $18 a ton bidding for space for urea, for what is probably a trial lot of 900 tons, from Trinidad to Abo (Finland).

British interest in imported ammonium phosphate was highlighted during March by a strike of dockers and tugboatmen which immobilised the ports of Avonmouth, Bristol and Portishead, into which come a large proportion of the country's imports of zinc concentrates, bauxite and rock phosphate. This strike, unofficial at first but later backed by the Unions, immobilised the whole area for 12 days and at one time involved 44 ships. It started by a refusal by the workmen to handle this dusty material until the port employers agreed to pay them "dirt money"—met by a refusal by the other side to discuss the matter in the face of a peremptory stoppage of work. Thus the record of U.K. ports was further blackened in the eyes of foreign shipowners. Senseless disputes such as this are one of the principal reasons why British importers have to pay as much as 10s.-15s. a ton extra freight on their raw materials compared with their competitors on the Continent.

As to the future of freights, the supply situation of conventional tramp ships in the 10-12,000 tons class, most favoured by the fertilizer trade, as well as very many other users, appears to getting tight. In addition to China and Japan, already heavy operators on timecharter, the U.S.S.R. has recently added a big call for 12 months cover and commercial interests throughout the world all require vessels of this limited size. While no-one would predict a general boom in freights embracing the larger carriers, it cannot be excluded that later this year rates for vessels of 12,000 tons and under may rise sharply.

Fertilizer Freights*

Importing Area	Shipment from	APRIL FREIGHTS 1961	1960	1959
South China	N.W. Europe	63s. 6d.	65s. 0d.	55s. 0d.
,,	Adriatic	59s. 6d.	57s. 0d.	52s. 0d.
India/Pakistan	Adriatic	41s. 0d.	46s. 0d.	40s. 0d.
,,	N.W. Europe	48s. 0d.	43s. 0d.	43s. 0d.
,,	U.S. Gulf	$10.20	$8.55	$9.00
,,	British Columbia	$8.55	$9.00	$8.40
India	Chile	92s. 6d.	100s. 0d.	95s. 0d.
Taiwan	U.S. Gulf	$9.35	$7.65	$7.50
,,	N. Pacific	$7.35	$7.30	$6.00
Philippines	N. Atlantic	$9.20	$7.50	$7.30
,,	N.W. Europe	$8.25	$7.70	$7.15
Greece	N.W. Europe	31s. 0d.	32s. 0d.	29s. 0d.
,,	U.S. Gulf	$6.95	$6.75	$6.10
Egypt	N.W. Europe	32s. 0d.	34s. 0d.	32s. 0d.
,,	Adriatic	19s. 6d.	18s. 6d.	17s. 0d.
Brazil	U.S. Gulf	$5.50	$5.50	$5.60
South Africa	N.W. Europe	44s. 0d.	39s. 3d.	38s. 3d.

* Per long ton net, exclusive of loading and discharging costs.

Chilean Nitrate Production in 1960

CHILE'S nitrate industry in 1960 suffered some of its severest set-backs since the development of artificial nitrates nearly 50 years ago.

Adversely affecting the industry in which production declined by 334,773 tonnes (27%) to 929,453 tonnes, were higher costs in operations and a shrinking market. Potassium nitrate production increased, however, by 23% to 82,548 tonnes during the year under review.

Contributing to the decrease in production of nitrate during the second quarter of 1960 was the strike at the Victoria plant of Cia. Salitrera de Tarapaca y Antofagasta (Cosatan) in April-May 1960, which required Government intervention* and was followed in the second quarter by suspension of mining operations at the company's Humberstone plant. Output continued to decrease during the third and fourth quarters, owing to a strike at Anglo-Lautaro Nitrate Company's plants at Maria Elena and Pedro de Valdivia from September (17th) to November (15th) and to the fall in production at the Victoria "officina" now operated by Empressa Nacional de Mineria. Some 6,500 workers were affected by the strike which was settled by a 10% increase in basic pay.

Combined Production

At the end of 1960 only three small independent nitrate producers were operating. Chile-Alemania, Chile, and Flor de Chile are expected to close by the end of the first half of this year. Combined production of these two companies was only some 3,000 to 4,000 tonnes a month. Government intervention is not expected.

A loan of $16 million from the Export-Import Bank to Anglo-Lautaro made in 1956 enabled some progress to be made in the company's improvement and expansion programmes. Nearly completed last year were the mechanical loading facilities at Toco Pilla, and two of five new Mordhery diesel power units at the company's Pedro de Valdivia plant were in operation.

Strikes affected production and exports

Domestic Consumption

Chile consumed 86,093 tonnes of natural nitrate in 1960. Of this total 63,000 tonnes was used in agriculture and the remaining 33,000 tons employed for various industrial purposes including the manufacture of explosives. To encourage the nitrate industry the Government is subsidising farmers for 30% of the costs of the natural fertilizer used on potatoes and wheat crops.

Sodium Nitrate Exports

Principal market for Chilean nitrate in 1960 was again the United States; France, Spain, Egypt and Brazil were the other major consuming areas.

Of these only Egypt has increased its imports of sodium nitrate, up 5,901 tons. The market in Spain has dropped slightly from 158,856 tonnes by some 24,200 tonnes while exports to Brazil show a decline of 10.8%. Exports to Portugal (−74.5%), Argentina (−66.5%), West Germany (−112%) and Spain (−39.5%) have shown the steepest falls.

In the fertilizer year 1958-59 exports declined by 5.9% to 1,002,257; comparing the first nine months of 1959 with 1960 there has been a 16.8% decline in Chilean sodium nitrate exports.

That this large decline was due to the two

Chilean Nitrate Production

Tonnes

	1st quarter	2nd quarter	3rd quarter	4th quarter	Total
Anglo Lautaro Nacionade† ...	24,346	214,916	188,700	105,997	750,959
Empresa Mineria (Victoria) ..	37,035*	20,395**	25,413	26,346	109,189
Other Products	17,156	17,457	16,878	17,814	96,305
	295,537	**252,768**	**230,991**	**150,157**	**929,453**

† Guggenheim process—all others Shanks * Including potassium nitrate
** Including Cosatan production at Victoria and Humberstone

* Nitrogen No. 7, September 1960, p.39

severe strikes at Cia Salitrera and particularly at Anglo-Lautaro, which lasted for nearly two months in the latter half of the year, is shown by the results for the first half of 1960, i.e., January to June. The fall was 7.8% compared with the same period in 1959.

Of other markets taking sodium nitrate, Yugoslavia increased its nitrate imports by 50% and Belgium by 56.5%.

Potassium Nitrate Exports

Exports of potassium nitrate were affected, particularly in the latter half of the year. In the first nine months of 1960 there was a 14.5% drop compared with the like period in 1959. In the second half of 1960, however, exports declined by 56.5.

A striking decrease in exports of potassium nitrate to Brazil is noted (−68.7%), and also to the United States (−50%), in the first half of the fertilizer year 1960-61. In the case of the latter country this is due to the increase in U.S. production of this nitrogenous material which has received special attention within the last year.

Peru's exports have also declined by 3,450 tons to 1,902 in the same half year.

Stocks

At the year end (31 December 1960) stocks were at a record high level; a large part of these were already sold but held up by the strike at the Tocopilla docks.

Prices

Prices for both sodium and potassium nitrate decreased U.S. $1.50 a ton by the end of 1960. Typical prices quoted were U.S. $35 and U.S. $45 respectively a ton f.a.s. Chilean ports. The additional $4 a ton for bagged nitrate remains unchanged. Prices are, however, subject to negotiations. Thus, a sale of 80,000 tons was made to Egypt in March 1960 at U.S. $34 per ton c.i.f., in bulk, for Shanks type.

Federation Chemicals' Plant Now Fully Operational

TRINIDAD'S first nitrogen fertilizer plant, situated at Point Lisas, Claxton Bay, and operated by Federation Chemicals Limited, a Bermuda registered company formed in 1958 by W. R. Grace and Company of New York, U.S.A., is now fully operational. The plant which cost B.W.I. $20 million, produces ammonium sulphate and urea using as feed-stock natural gas piped from oilfields in the southern part of the island. Sulphur recovered at Texaco's large oil refinery at Point-a-Pierre, situated five miles from the fertilizer works, supplies about 20% of the 60 tons of sulphur required for the sulphuric acid unit. The balance is imported.

Fertilizer Production

Production of ammonium sulphate and urea is expected to reach 85,000 tons and 28,000 tons a year respectively. Annual capacity of the ammonium sulphate plant is 95,000 tons and that of the urea plant which uses the Stamicarbon process is 35,000.

Main contractors were C. F. Braun of New York, with M. W. Kellogg engineering and constructing the ammonia unit. The Stamicarbon process for urea is used.

Export Markets

Some 15% of the ammonium sulphate output will be sold on the domestic market and the remainder will be exported, mainly to Central and South American markets. At present local consumption of urea is comparatively small but the Caribbean area, and Central and South America in particular are expanding markets and increasing demand for urea in cultivation of citrus fruits, pineapples, bananas, etc., which is already substantial, is readily increasing.

The Government of Trinidad has a scheme whereby free distribution of fertilizer will be effected for a five-year period. Funds are to be provided from local colonial development and welfare allocations but must be matched by contributions from the local governments.

Expansion of Nitrogen Production in Roumania

Could lead to the country becoming an exporter

UNDER the current Six-Year Plan 1961-66 Roumanian agricultural industry is to receive this year nearly 450,000 tonnes of chemical fertilizers and for 1965 the target is set at 800,000 tonnes.

Fertilizer Production in Roumania
'000 tonnes—100% N_2 + P_2O_5 content

1938	1951-56*	1956	1957	1958	1959	1960†	1965†
—	4.3	12.7	18.2	28.9	52.0	140	500

* Yearly average. † Planned targets.

Roumania's few pre-war chemical works were small, outdated and uneconomic. During the course of the first (1951-55) and second Five-Year (1956-60) Plans a series of new chemical works has been added, and in particular fertilizer production has been expanded. In 1959 nitrogen fertilizer production amounted to 31,000 tonnes N, almost all of which has been based on natural gas—only at Huneadora is ammonia produced from coke-oven gas. The new works are wholly based on natural gas which is renowned for its purity and of which the country has large reserves.

New Plants

The first large-scale fertilizer plant at Fagaras—also known as chemical combine No. 1 was completed in 1959. It is still being run in and will eventually produce 100,000 tonnes ammonium nitrate a year. Due to be commissioned shortly is the Roznow combine. It will have an annual capacity of 100,000 tonnes ammonia, which it is reported will be converted to 210,000 tonnes of nitrogenous fertilizers and 10,000 tonnes of urea, implying that the latter will be used for "technical" purposes. Further expansion is to bring capacity to 350,000 tonnes N in 1965.

At Victoria, the Stalin chemical combine produces nitrogenous fertilizers, and at Novodari, where sulphuric acid and superphosphate production is concentrated, provision is being made for ammonia production.

Under the current Six-Year Plan two further fertilizer plants will be built. These will be at the Craiova combine, where construction started last year (1960), and the Tirgu Muresch combine—also known as chemical combine No. 2 — where building was begun in 1959. After 1965 Craiova will produce 420,000 tonnes of nitrogenous fertilizer and the Tirgu combine 500,000 tonnes N, including 100,000 tonnes of urea.

Current Six-Year Plan

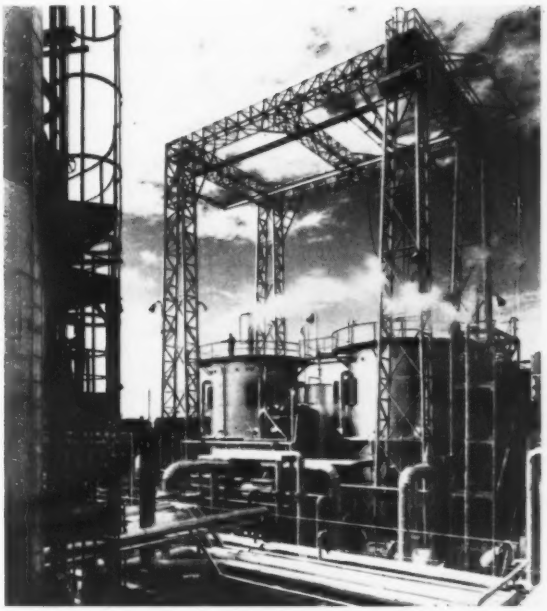
The crux of these ambitious plans is the rate of growth of consumption. Despite the virtual absence of synthetic fertilizer use, Roumanian agricultural output has hitherto been prolific and it seems that the Roumanian farmer will have to be educated to the use of synthetic manures, in much the same way as his counterpart in underdeveloped countries. The forced collectivisation of farms will, of course, facilitate the execution of official plans to step up the use of synthetic fertilizers. Failure to achieve this, however, would turn Roumania into yet another exporter of nitrogenous fertilizers.

Roumanian Fertilizer Works in Production or Projected

Plant	Tonnes/year	Product	In operation
Novodari	75,000-100,000	Ammonia	1959
Diciosanmartin	—	N Fertilizers	1916
Borzesti/Onesti Refinery No. 10	210,000 N	N Fertilizers	1956-1964
Fagaras Chemical Combine No. 1	50,000	Ammonia	
	80,000	Nitric acid	
	100,000	Ammonium nitrate	
Roznow	—	Ammonia	
	—	Nitric acid	
	100,000 N target	N Fertilizers	1961
	200,000 N		
I.W. Stalin Chemical Combine	—	N Fertilizers	1962
	—	Ammonia	
Tirgu Muresch (Construction started 1959)	100,000	Ammonia	By 1965
	500,000	N Fertilizers	
	100,000	Urea	
Craiova Chemical Combine (Construction started 1959)	420,000 N	N Fertilizers	By 1965
	—	Ammonia	

Chemico Methane Reforming Furnace Produces NH_3 Synthesis Gas at 250 p.s.i.g.

In operation at ONIA's Toulouse plant



The high pressure gas reformers designed by Chemico (New York) for the ONIA ammonia plant in Southern France which operates at 250 p.s.i.g.

THE high-pressure gas reforming furnace designed by Chemical Construction Corporation (Chemico) of New York represents, according to the company, a major break-through in gas reforming. Operating at 250 p.s.i.g.—believed to be the highest pressure in use at any plant in the world*—the unit was brought on stream late last year at the 200-tonne-a-day ammonia plant of Office National Industrial de l'Azote (ONIA). It eliminates the necessity, Chemico state, for several compression stages normally required in a plant of this type. Natural gas feedstock is reformed at high pressure (250 p.s.i.g.) and produces hydrogen for use in ammonia synthesis.

$$CH_4 + 2H_2O \longrightarrow CO_2 + 4H_2$$

Operation at High Pressures

During recent years the trend in the design of Chemico plants has been toward higher pressures, and in respect of high pressure reforming the advantages are seen as follows:—

(a) Higher pressure of feed gas prior to reforming lowers the overall amount of compressor horsepower required.

(b) The higher the operating pressure, the higher the value of condensate as heat source. Reforming is carried out with an excess of steam which is recovered as condensate and the improved heat recovery augments the amount of heat that can be utilized in the rest of the plant.

(c) Natural gas feed for reforming is usually supplied at high pressure; operation at a high pressure requires less catalyst.

Natural Gas as H source

At the ONIA plant, which is some 100 miles from the natural gas deposits of Lacq, the gas is supplied at about 275 p.s.i.g. Part is used to serve as fuel for the primary reforming furnaces, the rest is passed through activated carbon to remove sulphur compounds.

The gas stream is combined with steam and the mixture is pre-heated to 700° to 800°F before entering the primary reforming furnaces. Here the feed passes downward through beds containing conventional nickel catalyst emerging at about 1,300°F with a methane content of about 8%. Flue gas goes to a waste heat boiler and an air heater.

Partially reformed gas enters the secondary reformer containing two beds of catalyst. Pre-

* The new 60,000 tons-a-year Grace plant at Big Spring, Texas (see page 38) will employ a reforming pressure around 300 p.s.i.g.

heated air at 700 to 800°F, and about 250 p.s.i.g., is combined in two stages with the gas, to provide the proper ratio of hydrogen to nitrogen in the final stream to the ammonia reactor. Temperature in the reformer varies from 1,600° to 1,800°F and the methane content of the exit gas is 0.2%. Heat from the product stream is recovered in a waste heat boiler and an air heater. Gas at 800°F passes to a converter containing chromium-promoted iron oxide catalyst. The exit temperature of the gas, which still contains about 3% residual CO_2 is 850°F. The gas stream is then cooled in three successive stages and cleansed by a potassium carbonate system for removal of CO_2 with two stages for counter-current absorption. After cooling, the gas is compressed and purified before passing to the ammonia synthesis reactor. Final compression is accomplished in two stages so that the ONIA plant has only three compression steps after gas leaves the reformer compared with six steps for Chemico's atmospheric pressure designs, drawn up in 1953.

Nitrilotriacetic Acid as Chelating Agent

ALTHOUGH it was commercially produced in the early thirties, nitrilotriacetic acid (NTA), the first synthetic amino acid type chelating agent, was superseded in a few years by the chemically related ethylenediamine tetraacetic acid (EDTA) which could be synthesised at a much lower cost.

Now it appears that NTA is coming back into favour. Hampshire Chemical Corporation, Poisson Avenue, Nashua, New Hampshire, U.S.A. manufacturer of chelating agents, claims to have developed an economical manufacturing process.

NTA and EDTA Compared

Amino acid chelating agents generally react with polyvalent metal ions on a mole to mole basis. Their relative efficiency is therefore directly related to their molecular weight. Since the molecular weight of NTA is only two-thirds that of EDTA, one part of it is capable of complexing the same amount of polyvalent metal as 1½ parts of EDTA. In other respects their properties are similar; they may be considered almost as chemical twins.

A quantitative method of comparing chelating agents has been studied by Hampshire Chemical Corporation. The equilibrium constant of the chelating reaction, the so-called "stability constant," is only of use in comparing the relative order of chelation of various metals with the same chelating agent. A more satisfactory method of comparing different chelating agents is the pM method in which pM represents the negative logarithm of the metal ion concentration. From this figure and from solubility product data it is possible to calculate whether a precipitate will form with a metal and a precipitating agent under any given set of conditions.

An examination of the chelating reaction:

$$NTAH^{--} + M^{++} \rightleftharpoons [NTA\ M]^{-} + H^{+}$$

indicates that the higher the hydrogen ion concentration (i.e., the lower the pH) the more M^{++} will be present. In most instances pH is the most important factor in the successful use of a chelating agent. Tables of pM values for NTA and EDTA have been worked out by Hampshire; these cover Cu^{2+}, Ni^{2+}, Pb^{2+}, Co^{2+}, Zn^{2+}, Cd^{2+}, Fe^{2+}, Fe^{3+}, Mn^{2+}, Ca^{2+}, and Mg^{2+}.

Applications for NTA

There are, of course, many applications of NTA. In agriculture it has been used to produce 2,4D herbicide concentrates which are completely soluble in hard water. It is recommended for addition to soaps and detergent formulations, especially in hard water areas. It renders proteins soluble and can be used for degumming silk, and in laundry, and dish-washing compounds. It will also dissolve most scale and sludges and is recommended for inclusion in industrial cleaning compounds.

There are also a number of applications claimed in the dyeing and textile industries, and in the production of synthetic rubber, tanning of pelts, and rare earth separations.

TVA Increased Liquid Fertilizer Production in 1959-60

DURING the year ended 30th June, 1960, the Tennessee Valley Authority produced 263,639 tons of fertilizer and munitions products, valued at $16,565,525, compared with 219,400 tons in 1958/59 and 240,000 tons in 1957/58. Of this amount 249,705 tons, valued at $15,528,242, was sold, the remaining 13,934 tons, valued at $1,000,893, being used in farm test-demonstrations and other programmes.

Largest bulk products were calcium metaphosphate (75,753 tons, against 73,495 tons in 1958-59) and ammonium nitrate (74,665 tons against 83,663 tons). Other products include superphosphate—high analysis (30,435 tons against 28,256 tons), diammonium phosphate (24,999 tons against 21,323 tons) and ammonium phosphate nitrate (25,787 tons against 9,232 tons). Allowing for a net income on some products and losses on others, fertilizer and munitions products involved a net expense of $36,390. In the previous year the expense was $1,300,000.

Sales of fertilizer materials are not made by TVA on a commercial basis, but are made to organisations collaborating in an educational programme aimed at improving the manufacture, distribution and use of fertilizers.

Development of ammonium polyphosphates

Cost of Research

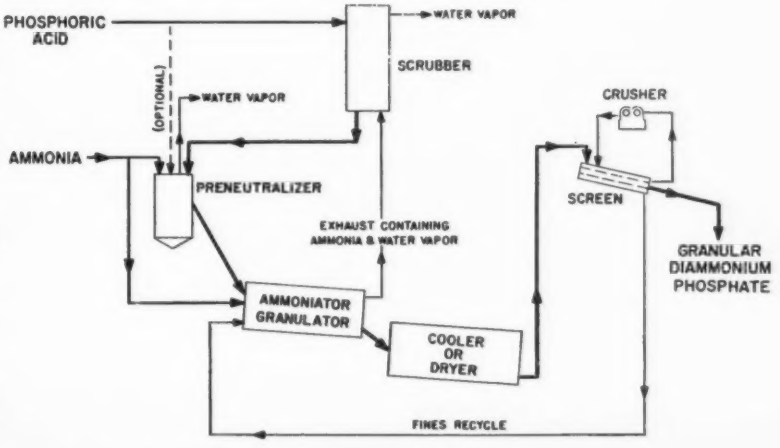
Research on products and processes during 1959/60 cost $1,864,000, an increase of 3.3% over the previous year's figure of $1,804,000. In general the amounts spent on research have not varied much between 1958/59 and 1959/60. However, there was a sharp increase, from $26,000 to $70,000, in the amount spent on nitrogen fertilizer processes, matched by a decrease from $57,000 to $19,000 spent on development of these processes.

Fertilizer testing and demonstrations, and agricultural development cost $1,545,000, compared with $1,499,000 in the previous year. Total net expense on fertilizer, agricultural and munitions development was $4,864,000, compared with $5,953,000, a decrease of 18.5%.

Tables I and II give details of expenditure on research on products and processes and on fertilizer testing and demonstrations and agricultural development.

Liquid Fertilizers

During 1959/60 TVA issued 29 licences to 16 companies to use its liquid fertilizer processes. At the same time TVA increased its own production by over four times, from 2,700 tons in 1958/59 to 12,000 tons in 1959/60.



Flowsheet of TVA process for production of granular diammonium phosphate

Liquid fertilizer was shipped by water for the first time during the year. A 1,218 tons shipment was taken from Muscle Shoals to Dubuque, Iowa, and from there by road to six plants in Iowa and Minnesota. High-analysis fertilizer made from the TVA material was distributed through dealers in Iowa, Minnesota and South Dakota to co-operating farmers who will report their results with it.

Studies were made on the effects of varying temperatures on liquids in storage; on the production of materials with no-nitrogen or low nitrogen content, such as 0-25-25 and 3-12-12; and on liquids of low chlorine content for use on chlorine-sensitive plants such as tobacco.

First used in California, liquid fertilizers are becoming popular in other parts of the country. It is estimated that about 300 plants are now in operation compared with 167 three years ago. Total output is still small, however, amounting to 5% or less of total United States mixed fertilizer production.

Superphosphoric Acid

Superphosphoric acid, which is 40% more concentrated than regular acid, has been distributed by TVA since August 1957, in which time 51 licences have been issued covering fertilizer processes in which it is used. About 1,570 tons of superphosphoric acid was distributed to fertilizer manufacturers in 1959/60 for experiment and demonstration. The greater part went to companies producing liquid fertilizers.

A pilot plant has been put in action for concentrating wet process phosphoric acid. It has been found that clear liquid fertilizers as well as solid fertilizers can be made with the concentrated acid but not with regular acid. It is less corrosive, is more economical to ship, handle and store. Its decreased moisture content will reduce the drying time for granular fertilizers made from it.

Several large firms are building pilot plants to investigate the process. Regular wet-process acid is cheaper to produce than electric furnace acid but contains certain impurities which present storage and handling difficulties and render it unsuitable for making clear liquid fertilizers; in the concentrated acid these difficulties are eliminated or minimised.

Ammonium Polyphosphates

Ammonium polyphosphates are among the solid fertilizers of high concentration which are being developed by TVA. These are stated to be more concentrated in plant nutrients than any phosphate-nitrogen fertilizer now being

TABLE I

Research on Products and Processes * †

	1960	1959
	$ Thousands	
Research on nitrogen compounds	31	25
Research on phosphorus compounds	263	260
Research on nutrient combinations	47	49
Research on nitrogen fertilizer processes	70	26
Research on phosphorus fertilizer processes	169	84
Research on combination fertilizer processes	209	260
Development of nitrogen fertilizer processes	19	57
Development of phosphorus fertilizer processes	238	266
Development of combination fertilizer processes	162	157
General research expense including supervision, services, equipment and supplies, and other indirect expenses	540	506
Provision for depreciation	50	50
Administrative and general expenses; schedule F	66	64
Net expense of research on products and processes	**1,864**	**1,804**

* In the discharge of its obligations under Section 5 of the TVA Act, TVA operates plants for the manufacture of products for agricultural and military purposes; conducts research and pilot plant development of new or improved processes for the production of new or existing fertilizers and munitions; and tests the fertilizers produced and demonstrates their effectiveness. Production is carried out on an experimental basis and costs are consequently affected by the developmental nature of the manufacturing operations. "Research on products and processes" is not scaled to TVA's production operations. Its scope is determined by opportunities to render service in the public interest; findings are made available to the public through technical publications, answers to correspondence, and discussions with technical visitors to the laboratories and plants. For these reasons, the cost of such research is accounted for under a separate programme rather than as a part of production operations.

† The details of research expenses for 1959 have been restated to conform with the classification used in 1960.

TABLE II

Fertilizer Testing and Demonstrations and Agricultural Development

	1960	1959
	$ Thousands	
Farm test-demonstrations		
Fertilizers used	962	909
Income from farmer payments	580*	522*
Planning and supervision	502	486
	884	873
Basic agronomic research	426	396
Provision for depreciation of fertilizer-soil research laboratory	7	6
Fertilizer marketing studies and demonstrations	80	86
Economic research on Valley agriculture	37	30
Research on commercial farming problems	12	14
Research on soil productivity and management	—	4
Economic investigations of irrigation in Valley agriculture	13	10
Part-time farming research and demonstrations	19	19
Administrative and general expenses; schedule F	67	61
Net expense of fertilizer testing and demonstrations and agricultural development	1,545	1,499
Net expense of fertilizer, agricultural and munitions development	4,864	5,953

* Deduct

marketed. Good progress is reported on a continuous process for producing a solid ammonium polyphosphate from super acid and ammonia. Data were obtained for design of a pilot plant.

Diammonium Phosphate

Diammonium phosphate production increased by about one-third, from 21,000 tons to 28,000 tons (see Nitrogen 9). Improvements made in the plant have resulted in a better control of crystal size. On the pilot scale a process has been developed for producing granular diammonium phosphate fertilizer. Advantages of the process are that either electric furnace or wet process phosphoric acid may be used, the heat of the reaction may be sufficient to eliminate drying, and the process may be carried out in relatively inexpensive equipment now in use, such as the TVA ammoniator-granulator.

Nitrogen Fertilizers

A new ammoniator-granulator has been installed, replacing the experimental model that was producing about 89,000 tons annually of granulated nitrogen fertilizers. Higher production rates and better product control have been obtained as a result.

METERING TWO CORROSIVE LIQUIDS SIMULTANEOUSLY

A low - capacity metering pump able to handle up to 500 gallons a day at 100 p.s.i. and equipped with interchangeable Tyril or Penton plastic heads to take a wide range of corrosive liquids has been developed by Wallace and Tiernan Inc., Belleville, New Jersey, U.S.A.

The single-head model can meter up to 250 g.p.d. and has a simple belt and pulley arrangement for lower rates of flow of 140, 80 or 40 g.p.d. The dual-head model can take 500 g.p.d.—either proportioning two different chemicals separately, or else handling twice the single-head capacity of the same liquid.

Stroke length is adjustable over a 10:1 range while the positive-displacement, diaphragm-action pump is operating. On the dual-head model, stroke length adjustment and indication for each head are separate.

Short stroke length and slow stroking speeds promise a long diaphragm life and leak problems are eliminated by the absence of stuffing boxes, shaft seals and packing glands.

There is an oil-enclosed, cam-drive mechanism which features force-feed lubrication, double bearings, oil-level window and no cantilever loads.

1000 S.Tons-a-day Fertilizer Plant for California Chemical Company

PRODUCTION capacity of more than 1,000 short tons of fertilizer a day is planned for the new plant of California Chemical Company's Ortho division, now under construction near Fort Madison, Iowa, U.S.A. To be one of the largest fertilizer plants in the world, it is in fact the largest single investment yet made in a fertilizer operation.

Output will include anhydrous ammonia, prilled ammonium nitrate, and pelleted complex fertilizers in various formulations. The plant is intended to serve the Middle Western and North-Eastern States.

The 419-acre site, bordering the Mississippi River, has been prepared by Cameron-Joyce Company, Keokuk, Iowa. Completion of the major buildings is scheduled for late this year.

Ammonia Plant

Contract for the ammonia plant has been awarded to the Bechtel Corporation. Based on hydrogen from natural gas supplied by the North Central Public Utility from the Michigan - Wisconsin pipeline anhydrous ammonia will be synthesized at a daily rate of 300 short tons.

Nitric Acid Plant

Chemical and Industrial Corporation will build the nitric acid plant to its own design, similar to those built for the Ortho fertilizer operations at Richmond, California, and Kennewick, Washington. A modification of the du Pont process is used in which ammonia is burnt and the nitrogen oxides absorbed under pressure.

Liquid ammonia, fed from storage tanks, is vaporized and superheated and fed into a mixer with the air stream from the air heater. The mixture is passed to a converter and reacts on a platinum-rhodium catalyst. The heat from the reaction is used to heat the incoming air stream and to produce process and heating steam. As a result, the nitric acid plant is self-sustaining.

The combustion gases then pass to a multi-pass horizontal cascade-type cooler, where oxidation of NO to NO_2 takes place. Acid formed in this cooler is delivered direct to the proper plate in the absorption column. Uncondensed gases enter the base of the column and flow upward countercurrent to water (steam condensate). The acid at the base of the column is swept by a stream of hot air or combustion gas and delivered to the storage tanks. The spent gas, mostly nitrogen, is reheated and used to drive the expansion turbine, thus providing a large proportion of the operating power of the plant.

Pelleted Fertilizer Plant

Pelletization using the Unipel process will be employed. Ground phosphate rock is acidulated with nitric acid to produce a slurry of soluble P_2O_5 compounds, calcium nitrate and minor amounts of other soluble salts, together with insoluble matter in suspension. The Spherodizer drying system, developed by Chemical and Industrial Corporation, will also be installed.

Ammonium Nitrate Plant

From 150 to 200 tons of prilled ammonium nitrate will be produced daily by the conventional neutralisation of 57% nitric acid with anhydrous ammonia at atmospheric pressure. The resulting 83% ammonium nitrate solution is concentrated in an evaporator to less than 0.25% moisture content. The molten ammonium nitrate is prilled in a short prill tower, and is then cooled, screened and coated, to produce a dense, free-flowing, spherical product.

Contracts for the complex plant, the nitric acid and the ammonium nitrate plants have been awarded to Chemical and Industrial Corporation, Cincinnati, Ohio.

current events

INDIA

Texaco Plant for Travancore

Fertilizers and Chemicals (Travancore) Limited has commissioned the construction of a Texaco partial oxidation gasification plant at Alwaye, Kerala, South India, from P.G. Engineering Limited, a member of the Davy Ashmore Group.

Hydrogen and carbon monoxide will be produced, followed by high pressure CO conversion, removal of CO_2 and residual H_2S by water scrubbing. Rated capacity of the plant will be just under 100 tonnes NH_3 a day.

Initially, the plant will process naphtha, but will be so designed that if fuel oil is used, the additional acid gas purification plant can be added.

An interesting feature of the plant is that carbon produced in the Texaco generator will be recovered and recycled. Particularly suitable for Indian conditions is the flexibility of the Texaco process as alternative fuels such as refinery gas, natural gas, naphtha and fuel oil can be readily processed.

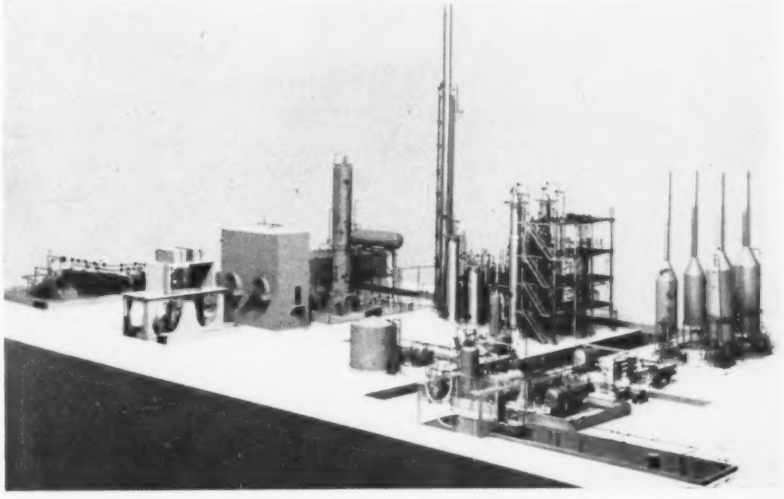
Plans in hand indicate that the company expects to produce 19,000 tonnes N by 1961. Production capacity for nitrogen products will be as follows: Ammonium sulphate, 13,000 tonnes N; ammonium phosphate, 6,000 tonnes N; ammonium chloride, 8,000 tonnes products (1,000 tonnes N).

Nangal Plant in Operation

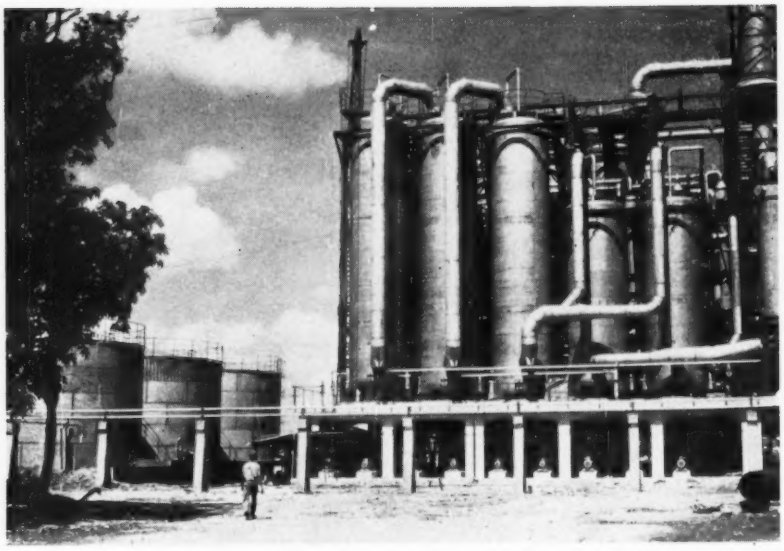
Now in operation is the £26.3 million fertilizer plant of Nangal Chemicals and Fertilizer Limited. Output initially is 300 tons a day of nitrogen fertilizers but this will gradually be stepped up to 800 tons a day as and when supplies of 159,000 kilowatts of power are available from Bhakra power plant. When operating at its full capacity the plant will produce 1,200 tons of fertilizer a day.

Set up by the Bhakra Dam, the fertilizer works at present occupy 500 acres.

The nitric acid unit at Nangal was constructed by Vitro Engineering Company, a division of Vitro Corporation of America. Sindri Fertilizers and Chemicals Limited has been responsible for the calcium ammonium nitrate plant. This is the first time that an Indian company has erected a major nitrogenous fertilizer unit in the country. This is also the first time that calcium ammonium nitrate has been produced in India, although this nitrogen fertilizer is well known in India, having been imported mainly from West Germany.



Model of the Texaco gasification plant being constructed by Power Gas Engineering at Travancore, India, for Fertilizers and Chemicals (Travancore) Limited



The nitric acid plant at Nangal built by Vitro Engineering Company

UNITED STATES

Grace's 60,000 tons New NH_3 Capacity

Now in operation is the 60,000 tons of new ammonia capacity at the Memphis plant of the Nitrogen Products Division of W. R. Grace and Company. The new unit, which employs the methane steam-reforming process, brings overall ammonia capacity of the Memphis plant to over 160,000 short tons a year.

The additional ammonia capacity will satisfy Grace's in-plant requirements of the raw material for urea production and outside customers who have increased their consumption of ammonia. Until the new unit was on stream the Memphis urea plant obtained part of its ammonia requirements from outside sources. Urea capacity, originally 50,000 tons a year, was doubled in 1959 making the Memphis plant the third largest urea facility in the U.S.

Grace has also announced that it will build a new ammonia plant at Big Spring, Texas, to supply fertilizers to the rapidly expanding agricultural area in the western part of the State. This plant, which will be constructed by Foster Wheeler Inc. and will be on stream early in 1962, is expected to produce in excess of 60,000 tons of ammonia annually. The unit will adjoin the Big Spring, Texas, oil refinery of Cosden Petroleum Corporation and will be operated for Grace by Cosden, in which company Grace has a 53% share.

In addition to the company's plants in the U.S.A. Grace has a 49% interest in an ammonia plant in Puerto Rica, managed by Caribe Nitrogen Corporation, and another in Trinidad, British West Indies, operated by Federation Chemical Limited. (See page 33).

In the last seven years Grace has constructed five ammonia plants, making the company one of the largest producers of ammonia in the U.S. Three of the five installations have come on stream since 1959.

Dimethylhydrazine Plant Expansion

Capacity for production of unsymmetrical dimethylhydrazine, UDMH, is to be increased at the Baltimore plant of Food Machinery and Chemical Corporation. For security reasons no details are as yet available of the size of the expansion. UDMH—F.M.C.'s trade name for the product is Dimazine — is an important outlet for dimethylamine, produced by Commercial Solvents E.I. du Pont de Nemours and Company, Pennsalt Corporation and Rohm and Haas Inc., and is used in rocket fuels where it is burnt as a 50% mixture with hydrazine, using nitrogen tetroxide as oxidizer; the latter is supplied by Hercules Powder Com-

pany and Allied Chemical Company. F.M.C. expects to supply the U.S. Air Force with 5 to 15 million pounds a year for several years under a long term contract.

The leading hydrazine producer in the U.S.A. is Olin Mathieson Chemical Corporation with a 4 million lb.-a-year plant at Lake Charles, La., and another at Saltville, Va., the latter being favourably sited in relation to F.M.C.'s UDMH plant at Baltimore.

Of the three major raw materials for hydrazine, Olin at Saltville, already produces two, chlorine and caustic. The third raw material is ammonia which Olin acquires from nearby ammonia producers as its wholly-owned ammonia plants at Lake Charles, La., and Niagara Falls, N.Y. — with an aggregate capacity of 95,000 tons N — are too distant. The ammonia required in hydrazine manufacture at Saltville is likely to be under 1% of the company's installed ammonia capacity.

New Air Separation Plants in U.S.

For SunOlin Chemical Company in Delaware Air Reduction Inc. is to build a $5 million air separation plant having a daily capacity of 350 tons of oxygen and high-purity nitrogen to be produced initially at a daily rate of 25 tons for use in chemical processing, primarily ethylene and ethylene oxide. Air Reduction has also received a contract to build and operate a 675 tons-a-day oxygen plant at the Johnston, Pa., plant of Bethlehem Steel Corporation. The unit which is due to be completed late this year, will presumably also produce a significant volume of gaseous or liquid nitrogen, estimated at over 500 tons.

Also building a $6 million oxygen-nitrogen plant for Bethlehem Steel is Air Products Inc. This plant will be at Sparrows Point, Md. works and will produce 350 tons of high purity oxygen and 450 tons of nitrogen a day when it is completed at mid-year.

For rocket engine development facilities at Fort Crowder Reservation, Neosho, Mo., Linde has built a liquid oxygen-nitrogen plant which is now in operation. The plant has a capacity of 140 tons a day of liquid oxygen and nitrogen, and will also supply other industrial gas consumers in the south-west. It is the fourth of five plants being put up Linde Company for the U.S. aerospace programme. Two other liquid oxygen-nitrogen plants are in operation, one at Pittsburg, California, and the other at Huntsville, Alabama. The other plants are a 65 tons-a-day liquid hydrogen plant at Torrance, California, and construction of another with a capacity of 26 tons a day at Fontana, California.

About 41% of total oxygen-nitrogen operating capacity of captive and commercial plants is taken up by the U.S. chemical industry. Including nitrogen used for ammonia synthesis this represents about 4,300 tons/day of oxygen equivalent.

Principal process users and approximate tonnage involved are assessed as follows:—

Ammonia synthesis gas (both oxygen and nitrogen	1,500 tons/day
Acetylene	1,600 tons/day
Ethylene oxide	600 tons/day
Oxidation of propane and butane ...	400 tons/day
Methanol synthesis gas	200 tons/day

MEXICO

Urea Plant for Salamanca

Plant for production of urea is projected by Fertilizantes del Bajio S.A., the subsidiary of Sociedad Mexicana de Credito Industrial. Capacity of the new urea facility will be 57,000 to 60,000 tonnes a year, and 100 tonnes a day of ammonia at the Petroleos Mexicanos plant will be processed. Site of the plant will be at Salamanca, in the state of Guanazuato.

At the present time, a purchasing team is visiting Holland and Belgium and is engaged in making arrangements for the necessary equipment for the plant.

Ammonia required for urea manufacture will be obtained through a contract with Sociedad Mexicana from Petroleos Mexicanos.

PERU

Fertisa in Production

Now in production is the fertilizer plant of Fertisa S.A., at Callao. The plant was designed, built and put into operation under the direction of Soc. Montecatini, of Milan, Italy; using the Montecatini processes, it produces nitrogenous fertilizers from fuel oil.

Based on an annual output of 20,000 tons synthetic ammonia, some 15,000 tonnes of nitric acid is being produced.

PORTUGAL

Ammonia and Urea Complex for Uniao Fabril do Azoto

Uniao Fabril do Azoto, Lisbon, has awarded contracts for its ammonia and urea plants, off-site facilities and construction of all major process facilities for its new fertilizer complex to be set up at Lavradio on the south bank of the Tagus, near Lisbon, to M.W. Kellogg Company, New York, U.S.A., and two of its subsidiaries, Kellogg International Corporation London and Kellogg of Panama Inc. M.W. Kellogg and Kellogg International are engineering the 180 tonnes/day ammonia and 40,500 tonnes/year urea plants with Kellogg International having responsibility for off-site facilities and procurement of materials in the U.K. while Kellogg of Panama is handling procurement in Portugal and carrying out all construction except for administrative buildings.

The new complex is scheduled to be completed in 1962 and will include besides the ammonia and urea plants, nitric acid, ammonium nitrate and lime ammonium nitrate plants. C and I/Girdler International Limited, Nassau, Bahamas is undertaking engineering and procurement of the plants which are due to be in operation by summer, 1961. Ammonia will be obtained from the company's Alferraredo works.

Production capacity at the Alferraredo plant is 20,000 tonnes N a year based on the use of electrolytic hydrogen. The I.C.I. version of the Haber Bosch process is used for ammonia synthesis. Some ammonia (700 tonnes) is sold each year in anhydrous or solution form, the balance being used in ammonium sulphate manufacture at Barreiro.

For the new plant at Lavradio Uniao Fabril will purchase, in addition to its own production, some 15,000 tonnes of anhydrous ammonia from Sociedade Portuguesa de Petroquimica. The extension to the ammonium sulphate plant at Barreiro, which will increase capacity from 130,000 tonnes a year to 240,000 tonnes, is now being commissioned. Feedstock for this plant will be naphtha for hydrogen production. The ammonium nitrate plant, scheduled to be in operation this summer, is a 60,000 tonnes a year unit.

The company expects to produce this summer 18,000 tonnes of 100% ammonium nitrate and ammonium sulphonitrate. When fully operational some 83% ammonium nitrate capacity will be available in the form of slurry for sale to the company's mixed fertilizer works and part for lime ammonium nitrate and part for ammonium sulphonitrate. Uniao Fabril is the sole producer of complex fertilizers which amount to 20,000 tonnes a year. Formulas available are as follows: 7-7-14, 14-14-0, 10-10-10, 3-18-0, 10-20-0, 7-14-7, 7-21-7, 7-21-0, 6-8-8 and 7-11-0. Last year (1960) superphosphate production totalled 201,133 tonnes (36,019 tonnes P_2O_5) and 39,790 tonnes (17,289 N) of concentrates.

Nitric Acid for Explosives

Sociedade Portuguesa de Explosives Lda., of Lisbon, is now producing 1,000 tonnes of nitric acid (100%) for the manufacture of explosives. Eighty per cent of the acid produced is utilized by the company for captive consumption and the remainder is sold to manufacturers of explosives.

Ammonium nitrate imports amounting to 1,800 tonnes a year are obtained from Western Germany, Belgium and France. Until recently Great Britain was also a supplier, but according to the Portuguese the last U.K. quotations were too high. Within a year Portugal expects to be able to produce ammonium nitrate for explosives. At present this nitrogen product is only made for fertilizer use. Plans for production are such that domestic demand will represent about two-thirds of output.

FRANCE

Nitrogen Works at Donges

Soc. Chimiques de la Grand Paroisse is to construct a large nitrogen fertilizer works covering some 30 hectares at Donges, using hydrogen from the nearby Antar des Petroles refinery and Lacq gas.

In the first phase, plants will be built to produce ammonia, nitric acid and ammonium nitrates. Calcium required in the manufacture of lime ammonium nitrate will be obtained from the surrounding district. Production capacity will be 200,000 to 250,000 tonnes of fertilizer a year, a large part of which will be exported through the port of Saint-Nazaire.

SYRIA

Site chosen for N Fertilizer Plant

Soviet experts have chosen a site east of Outteina Lake, 15 kilometres from Homs, for the proposed nitrogen fertilizer plant (a technical report is now being prepared for the Syrian Ministry of Industry). Cost of the plant is estimated at about 100 million Syrian lire, of which 60 million lire will be required for plant equipment. The plant is expected to take three to four years to build.

Last September, Vice-President Dr. Nureddin Kahale signed a contract in Moscow for the construction of this plant under the Technical and Economic Co-operation agreement of 1957. The contract provides for construction of the plant to be completed in two stages — the first in 1964 and the second in 1966.

The plant will be sited near the adjacent oil refinery built by Techno-Export of Czechoslovakia and will use waste refinery gas as feedstock. Initially 45,000 tonnes of ammonia will be produced. Ultimately the ammonia production will be 120,000 tonnes a year. Initially 100,000 tonnes a year ammonium nitrates (33,000 tonnes N) will be produced.

Foster Wheeler Limited, of London, has made full technical and financial proposals for the design, engineering and construction of the fertilizer plant, but it is expected that the contract will be awarded to the Czech concern which built the Homs refinery.

INDONESIA

Urea Plant Contract

A contract for the design and construction of a urea and synthetic fertilizer plant has been awarded by the Government of the Republic of Indonesia to Morrison-Knudsen International Constructors, Inc., of San Francisco, California, U.S.A. The plant will be built on the Musi River near Palembang, Sumatra and is expected to cost about U.S. $38 million financed by credit from the Export-Import Bank.

Urea will be manufactured by the Toyo Koatsu process, using natural gas piped to the site from nearby gas fields, and production capacity of the plant will be 100,000 tonnes urea a year. Full capacity is scheduled to be attained in 1964 when the plant will be taken over by the Indonesian concern, P.T. Pupak Sriwidjaja, which will operate it for the Government. The plant will supply about one-half of Indonesia's fertilizer requirements and will result in a considerable saving of foreign currency.

Morrison-Knudsen Constructors, in addition to designing and constructing the plant, will handle all initial operations of the plant and undertake the training of Indonesian technicians. Associated with Morrison-Knudsen Constructors in the project will be its wholly-owned subsidiary, H.K. Ferguson Company, Cleveland, Ohio, and Girdler Corporation of Louisville, Kentucky. The project includes docks, site works and auxiliary facilities to the processing plant.

In 1959, the Indonesian Government contacted several U.S. contractors and negotiated with the U.S. Export Import Bank for the erection of a urea plant. This fertilizer project was originally awarded to Foster Wheeler Corporation, U.S.A., but was shelved last year when the latter withdrew owing to difficulties arising on training operators for the plant. It had been hoped that the plant would be brought into operation in 1961 or 1962. At present Indonesia's nitrogen requirements are estimated 28,000 tonnes N a year, mainly in the form of ammonium sulphate and a small amount in the form of ammonium phosphates (about 500 tonnes N). Urea has not been imported since 1958 when imports amounted to approximately 150 tonnes N.

TAIWAN

U.S./Chinese Urea Facility

Expected to be constructed on Taiwan by a joint U.S./Chinese company is a major urea facility. Mobil Chemical Company, a division of Socony Mobil Oil Company, is to operate the plant in partnership with Chinese Petroleum Corporation through the jointly-held Taiwanese company.

Capacity of the plant would be 45,000 tonnes a year and the project would represent

the largest single foreign investment on Taiwan. The final decision to proceed is subject to approval by the directors of both companies and ratification by the Government.

In the fertilizer year 1959-60, Taiwan imported 781 tonnes of urea from Japan. Other fertilizers imported were as follows :—

Fertilizer	Country of origin	Quantity (tonnes)
Ammonium sulphate ...	Japan	324,700
Sodium nitrate	Chile	175
Sodium nitrate	W. Germany	200

JAPAN

Calcium Cyanamide Situation

Until recently, the manufacturers of calcium cyanamide in Japan had considerable difficulty in marketing their output due to the declining domestic demand, and as a result, manufacturers curtailed their production and several ceased operations altogether. With the growth in plastics production, however, domestic demand exceeded production by some 23,000 tonnes in 1959. The Ministry of Agriculture forecast for the 1960 fertilizer year that local demand of calcium cyanamide would be 323,000 tonnes product and manufacturers indicated their planned production of fertilizer or calcium cyanamide for the same period at 276,000 tonnes. At the request of the Government, the producers agreed to raise their planned output by some 6,000 tonnes on condition that the Government assured the necessary power supply; they also indicated the possibility of a further increase of output by some 10,000 tonnes.

As a result, the Ministry of Agriculture presented the following demand/supply programme for the 1960 fertilizer year.

Production	Local Demand	Shortage
292,000 tonnes	323,000 tonnes	30,000 tonnes

Based on the above plan, the Ministry of International Trade and Industry decided to import 30,000 tonnes to cover the deficit and the full quantity was imported from Taiwan.

In January 1961 the Government again decided to import an additional 11,000 tonnes but was only able to procure 4,700 tonnes from Taiwan. As there was no possibility of importing the balance from any other source at sufficiently attractive prices, the Government requested the industry to increase its production by some 6,000 to 7,000 tonnes and this was subsequently agreed by the manufacturers.

While domestic output of calcium cyanamide has decreased from 525,517 tonnes in 1955 to an estimated 300,000 tonnes in 1960, calcium carbide production was an estimated 1,887,440 tonnes. Output of synthetic fibres produced from carbide has shown a remarkable increase and producers have preferred to manufacture these items rather than calcium cyanamide.

In the future it is likely that Japan will continue to import relatively small quantities of calcium cyanamide but manufacturers can be expected to continue to maintain the present level of fertilizer calcium cyanamide production to avoid possible criticism by the Government of profiteering at the expense of agricultural production.

ARUBA

Nitrogen Products and Fertilizer Plans

Aruba Chemical Industries, a new company formed with United States, West German, Italian and Dutch capital, is to erect on the Dutch colony of Aruba in the Balashi area, plants for the production of ammonia, sulphuric acid, nitric acid, phosphoric acid, urea and synthetic fertilizer compounds. Construction of the plants, which are expected to be completed by 1963-64, will commence this summer. Some 50 million Dutch colonial florins (nearly £10 million) will be invested in the project. Building and operation of the ammonia plant will be undertaken by Standard Oil Company, of New Jersey, U.S.A., which is already established on Aruba, through its subsidiary, Lago Oil Company, at a site some six miles from the oil refinery which will supply refinery waste gases or fuel oil for ammonia synthesis. Standard Oil will have an interest in the ammonia plant, but not in the fertilizer units.

Phosphate reserves in the Seroe-Colorado area are being investigated with a view to possible exploitation and an industrial port is to be built at Balashi.

Continued Rise in Output and Sales of Norsk Hydro

OUTPUT of nitrogen products by Norsk Hydro Elektrisk Kvaelstofaktieselskab (Societe Norvegienne de l'Azote), Oslo, Norway, in 1959-60 reached a new record level of 257,000 tonnes N, an increase of 14,000 tonnes N (51.5%) compared with the results for the year 1958-59, according to the company's annual report. Production of calcium nitrate increased to 1.16 million tonnes and that of ammonium nitrate 48,000 tonnes.

Nitrogen Products

Due to the reduction in the water levels in the Telemark reservoirs, production at Rjnkan ammonia plant was reduced in September 1959 from about 530 tonnes a day to some 430 tonnes N a day, and a further reduction to about 335 tonnes N a day occurred in November. Since then, however, production has been increased to about 470 tonnes N a day.

NORSK HYDRO
Sales of Nitrogen products and other products

At Notodden, ammonia production ceased from October 1959 until February 1960, so that the power available could be used most rationally.

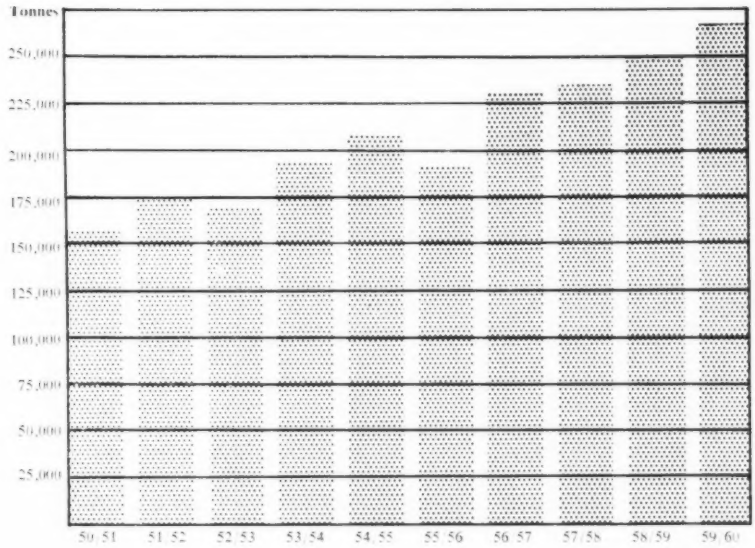
The electrolytic and auxillary electric installations have been overhauled and improved satisfactorily although production of ammonia has reduced from July to November 1959, but a high level of production was achieved during the other months of the year.

Production in the form of finished nitrogen products, however, reached a new record and some 257,000 tonnes N were produced as against 243,000 tonnes N in the preceding financial years.

A new large air compressor (20,000 N m^3/hr.) has been ordered for Eidanger. Reconstruction of the evaporation plant for calcium nitrate has been completed and the facility came into operation in December last year.

Enlargement of the urea facility to allow production of up to 100,000 tonnes a year is under way. The greater part of the plant was delivered and installed during the year under review. Rated capacity, which is 250 tonnes a day, was achieved in October 1960.

A further expansion of capacity to 360 tonnes a day, expected to be available this year, is being



Production in tonnes N at Norsk Hydro in period 1950-60

studied. Construction of a new store for urea was completed by December 1960.

Technical Nitrogen

The usual amount of technical nitrogen has been produced, or about 10,000 tonnes N, of which 4,000 tonnes was in the form of nitric acid and an equivalent amount in the form of ammonium nitrate.

Urea Output Increased

Output of urea has continued to advance and at 73,000 tonnes was 15,000 tonnes (26%) greater than in the previous year.

The complex fertilizer plant at Glomfjord produced 136,000 tons of A* and B* type complex fertilizers and the Eidanger Nitrate Works 63,000 tons of B* and C* type complex fertilizers. A and B type fertilizers contain traces of magnesium and sulphur.

For the financial year 1960-61, Norsk Hydro has already sold or set against option a major part of project production of nitrogen products. This is particularly the case with the company's principal nitrogen product—calcium nitrate. Small concessions have been made in prices; compared with the constant world growth of nitrogen, however, the company regards its position as satisfactory.

Fertilizer Markets

The greater proportion of nitrogenous products was again sold on the Scandinavian market where sales increased by 10%, although this market's share of total deliveries declined to 78% from 81% in the previous year. Overseas sales increased with new outlets for urea being found in the Far East, in Africa and in the Americas.

Almost 1,000 tonnes of nitrogenous products in the form of nitrogen solutions were sold to the U.S.A. during the year under review.

The greater part of nitrogenous fertilizer production for the year 1960-61 has already been disposed of and Norsk Hydro reports that the current position is satisfactory.

New Ammonia Plant Extension

During the year under review, Kr.53.8 million (£2.69 million) were expended on new investments which include new generating equipment at Sahheim and participation in construction of a new power station at Vrangfoss. Most of the equipment required to increase urea production to 100,000 tonnes a year has been installed.

Work has also been put in hand to increase output of ammonia at the Glomfjord plant from 65,000 tonnes to 86,000 tonnes a year. Norsk Hydro expects that the first stage will be completed in March this year and will account for approximately one-third of the planned increase.

Research Activities

Research has again centred mainly on nitrogenous products and plastics. In particular, research has centred in the improvement of the composition of complex fertilizers and work on improvement in manufacturing methods.

Several projects connected with improvement of processes have been taken up and partly applied in the urea plant.

Finances

Operating profits for the year 1958-59 amounted to Kr.105.7 million. Net profits amounted to Kr.20.6 million which together with Kr.9.9 million brought forward from the previous year produced a total of Kr.30.5 million available for distribution. A dividend of 9% as against 8% in the previous year is proposed.

* Believed to be: A 13.5 : 6 : 16 (NPK); B 11.5 : 5 : 17.5; C 15 : 6.7 : 12.

STATISTICAL APPENDIX

NETHERLANDS : Fertilizer Exports

AMMONIUM SULPHATE

Country	First Half Fertilizer Year 1959-60	First Half Fertilizer Year 1960-61	Difference
	Tonnes		
West Europe			
Belgium/Lux.	15	5	− 10
Greece	10,370	10,500	+ 130
Ireland	6,419	4,988	− 1,431
Portugal	990	792	− 198
Spain	10,800	6,400	− 4,400
Sweden	1,118	3,933	+ 2,815
United Kingdom	1,523	2,486	+ 963
Sub Total	31,235	29,104	− 2,131
East Europe			
Hungary	20,610	—	−20,610
Middle East			
Cyprus	574	347	− 227
Jordan	—	99	+ 99
Lebanon	—	297	+ 297
Libya	990	—	− 990
Sub Total	1,564	743	− 821
Africa			
Angola	—	2,336	+ 2,336
Canary Islands	3,465	—	− 3,465
Ethiopa	—	89	+ 89
Nigeria	—	85	+ 85
Port. East Africa	—	297	+ 297
Tanganyika	—	186	+ 186
Union of South Africa	5,326	3,162	− 2,164
Sub Total	8,791	6,155	− 2,636

AMMONIUM NITRATE & LIME AMMONIUM NITRATES

Country	First Half Fertilizer Year 1959-60	First Half Fertilizer Year 1960-61	Difference
	Tonnes		
West Europe			
Belgium/Lux.	2,299	1,640	− 659
Greece	3,012	10,942	+ 7,930
Portugal	4,812	2,882	− 1,930
Yugoslavia	—	39,766	+39,766
Sub Total	10,123	55,230	+45,107
Middle East			
Egypt	—	16,796	+16,796
Israel	500	—	− 500
Lebanon	—	444	+ 444
Sub Total	500	17,240	+16,740
Africa			
Port. East Africa	250	132	− 118
Rhodesia	2,619	636	− 1,983
Union of South Africa	2,958	3,629	+ 671
Sub Total	5,827	4,397	− 1,430
Asia			
China	—	9,799	+ 9,799
Philippines	—	500	+ 500
Thailand	197	370	+ 173
Sub Total	197	10,669	+10,472
North America			
United States of America	57,114	28,352	−28,762
Australasia			
Australia	—	1,275	+ 1,275
New Zealand	629	1,149	+ 520
Sub Total	629	2,424	+ 1,795
South America			
Brazil	—	1,138	+ 1,138
Others	43,632	43,293	− 339
Total	**118,022**	**162,743**	**+44,721**

Country	First Half Fertilizer Year 1959-60	First Half Fertilizer Year 1960-61	Difference
	Tonnes		
Asia			
Ceylon	—	9,142	+ 9,142
China	15,515	3,000	−12,515
India	19,092	5,093	−13,999
Pakistan	—	31,242	+31,242
Philippines	34,267	—	−34,267
Thailand	4,800	6,300	+ 1,500
Singapore	—	1,026	+ 1,026
Sub Total	73,674	55,803	−17,871
North America			
United States of America	—	9,811	+ 9,811
Central America			
Cuba	5,080	—	− 5,080
Guatemala	102	232	+ 130
Jamaica	4,862	—	− 4,862
Panama	—	185	+ 185
Salvador	2,419	2,445	+ 26
Sub Total	12,463	2,862	− 9,601
South America			
Argentina	2,759	1,183	− 1,576
Brazil	1,363	420	− 943
Colombia	—	248	+ 248
Peru	500	5,400	+ 4,900
Suriname	115	618	+ 503
Uruguay	980	45	− 935
Venezuela	197	—	− 197
Sub Total	5,914	7,914	+ 2,000
Australasia			
New Zealand	42	1,150	+ 1,108
Total	**154,293**	**114,324**	**−39,969**

AMMONIUM PHOSPHATE

Country	First Half Fertilizer Year 1959-60	First Half Fertilizer Year 1960-61	Difference
	Tonnes		
West Europe			
Belgium/Lux.	20	112	+ 92
Finland	49	—	− 49
Ireland	426	—	− 426
Sweden	57	—	− 57
United Kingdom	1,495	—	− 1,495
West Germany	30	—	− 30
Sub Total	2,077	112	− 1,965
Africa			
Mauritius	45	—	− 45
Nigeria	—	75	+ 75
Union of South Africa	27	—	− 27
Sub Total	72	75	+ 3
Asia			
Ceylon	35	—	− 35
Indonesia	1	—	− 1
Malaya	35	—	− 35
South Korea	—	1,825	+ 1,825
Thailand	—	100	+ 100
Sub Total	71	1,925	+ 1,854
South America			
Chile	20	—	− 20
Colombia	—	495	+ 495
Uruguay	140	—	− 140
Sub Total	160	495	+ 335
North America			
United States of America	—	1,816	+ 1,816
Central America			
Trinidad	25	—	− 25
Middle East			
Liberia	70	—	− 70
Total	**2,475**	**4,423**	**+ 1,948**

NETHERLANDS : Fertilizer Exports (contd.)

UREA

Country	First Half Fertilizer Year 1959-60	First Half Fertilizer Year 1960-61	Difference
	Tonnes		
West Europe			
Belgium/Lux. ...	654	1,144	+ 490
Denmark	85	172	+ 87
Finland	196	225	+ 29
Greece	70	130	+ 60
France	161	181	+ 20
Portugal	55	115	+ 60
Spain	425	1,051	+ 626
Sweden	2,729	1,368	— 1,361
United Kingdom ...	32	—	— 32
Sub Total ...	4,407	4,386	— 21
East Europe			
Czechoslovakia ...	50	695	+ 645
Africa			
Canary Is. ...	133	—	— 133
Congo	129	—	— 129
Guinea	—	49	+ 49
Kenya	—	254	+ 254
Port. East Africa ...	—	121	+ 121
Rhodesia	1,735	635	— 1,100
Tanganyika ...	240	—	— 240
Uganda	26	—	— 26
Union of South Africa	5,657	5,439	— 218
Sub Total ...	7,920	6,498	— 1,422
Asia			
Ceylon	30	—	— 30
India	1,036	81	— 955
Malaya	—	496	+ 496
Philippines	7,597	2,701	— 4,896
Port. India	—	197	+ 197
Singapore	—	149	+ 149
South Korea ...	27	—	— 27
Sub Total ...	8,690	3,624	— 5,066
North America			
United States ...	795	5,237	+ 4,442
Central America			
Costa Rica	167	370	+ 203
Dominican Republic	44	40	— 4
Honduras and British Honduras	11,771	1,748	—10,023
Guatemala	212	336	+ 124
Mexico	33	311	+ 278
Nicaragua	99	—	— 99
Panama	154	2,526	+ 2,372
Puerto Rica ...	91	499	+ 408
Salvador	303	220	— 83
Sub Total ...	12,874	6,050	— 6,824
South America			
Argentina	229	520	+ 291
Brazil	709	716	+ 7
Colombia	656	345	— 311
British Guiana ...	508	31	— 477
Ecuador	—	250	+ 250
Peru	—	70	+ 70
Suriname	—	30	+ 30
Venezuela	124	5	— 119
Uruguay	103	367	+ 264
Sub Total ...	2,329	2,334	— 5
Australasia			
Australia	—	71	+ 71
Middle East			
Egypt	—	125	+ 125
Iran	850	237	— 613
Sub Total ...	850	362	— 488
Others	1,382	—	— 1,382
Totals	**39,297**	**29,257**	**—10,040**

CHILE : Sodium Nitrate Exports

	Fertilizer year 1958/59	Fertilizer year 1959/60	Half year 1960/61
Panama	—	50	—
Germany West ...	42,980	20,060	9,830
Argentina	36,480	12,280	1,030
Australia	5,865	6,182	2,089
Azores	2,471	1,483	—
Belgium	28,648	38,898	14,596
Bolivia	32	76	33
Brazil	45,423	40,521	13,992
Canada	363	—	—
Colombia	161	315	100
Cuba	635	—	—
Denmark	15,050	20,000	—
China	—	10,345	—
Ecuador	802	1,000	—
El Salvador	1,484	989	250
Spain	158,856	134,643	20,389
United States	414,486	442,677	86,864
France	83,400	50,363	40,817
United Kingdom ...	16,083	14,274	502
Guatemala	50	199	198
Netherlands	11,500	10,242	6,702
India	19,084	27,292	—
Italy	27,090	30,000	—
Japan	15,594	17,037	5,220
Lebanon	—	1,487	1,483
Mexico	7,450	10,219	4,800
Nicaragua	150	250	75
New Zealand	1,168	2,864	1,858
Paraguay	—	5	—
Peru	6,467	8,261	4,228
Portugal	27,655	7,008	—
U.A.R. (Egypt) ...	42,332	48,233	17,030
Sweden	27,220	28,022	1,878
Uruguay	566	479	330
Venezuela	905	680	—
Yugoslavia	9,884	14,826	—
Costa Rica	297	—	—
Greece	—	988	—
Jamaica	—	—	—
Ireland	—	—	—
Total tons N ...	**168,200**	**163,650**	**37,500**
Total	**1,051,633**	**1,002,251**	**234,294**

Potassium Nitrate Exports

	Fertilizer year 1958/59	Fertilizer year 1959/60	Half year 1960/61
Argentina	3,000	2,000	—
Australia	15	596	89
Belgium	—	8,032	—
Bolivia	—	1	20
Brazil	2,200	24,740	4,561
Cuba	4,221	—	—
Ecuador	50	750	200
United States	37,000	36,000	10,000
United Kingdom ...	7,095	3,098	—
Guatemala	247	198	297
Netherlands	1	5	3,625
India	—	2	—
Lebanon	—	49	—
Mexico	250	—	600
New Zealand	—	1	11
Peru	8,464	6,978	1,902
Venezuela	115	80	—
France	—	20	—
Costa Rica	205	—	148
Nicaragua	—	—	25
Uruguay	—	—	100
El Salvador	494	—	—
Total	**63,358**	**82,548**	**21,578**
Total tons N 16%	**10,150**	**13,240**	**3,455**

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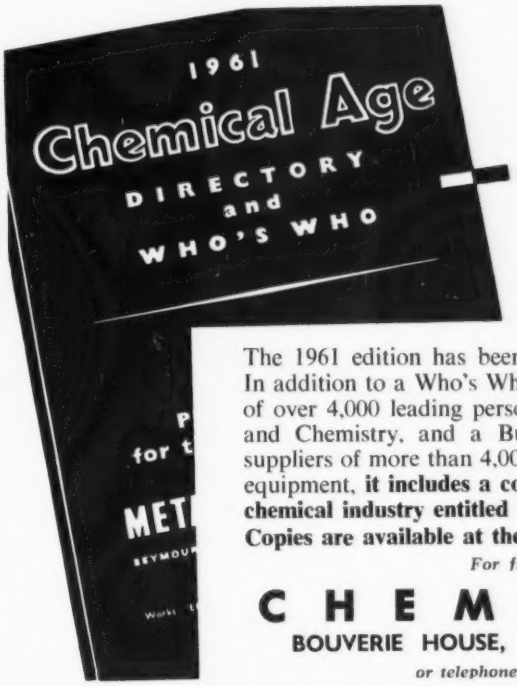

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